Asian Journal of Agricultural Sciences 2(1): 38-41, 2010
ISSN: 2041-3890

Submitted Date: November 24, 2009 Accepted Date: December 18, 2009 Published Date: January 10, 2010

Morphological Diversity in Germplasm of *Panicum antidotale* Retz

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Abstract: The study was conducted during 2005 for screening the best germplasm of a perennial grass *Panicum antidotale* Retz. from Cholistan desert, Pakistan. A total of nine accessions were assessed through morpho-anatomical characters and data generated, revealed considerable variation for flag leaf area, number of hairs on upper surface of the leaf, number of hairs on lower surface of the leaf, number of epidermal appendages at the margins of leaf base, thickness of leaf cuticle, number of stomata on upper surface of the leaf, stomatal index and number of epidermal cells on upper surface of leaf. Three accessions SH2/1, KWT1/1 and SH1/1 showed high variation and appeared as the best genotypes based on morpho-anatomical characters examined in this study. These accessions should further be tested under a wide range of environmental stresses such as drought, salinity and high temperature, to find stress tolerant ecotypes. This may be propagated for the restoration of degraded rangelands of Cholistan.

Key words: Accessions, cholistan desert, morpho-anatomical, *Panicum antidotale* and variation

INTRODUCTION

Panicum antidotale Retz., locally called as "Murrot or Bansi Ghaa" is a tall (upto 2.5 m), erect and much branched perennial grass and shows excessive production mainly on fertile sandy loam soils. It is a drought and salt resistant grass species and can withstand heavy grazing pressure with high protein value (Gul-e-Rana *et al.*, 1990). It also grows in association with *Calligonum polygonoides*, *Capparis decidua* and *Prosopis cineraria*. This association of *P. antidotale* with the above mentioned plant species in Cholistan desert gives the idea that this is the adaptation of the grass to escape the grazing pressure as animals get injured their mouth while trying to churn those plant species with which *P. antidotale* form associations. This has also assumed that this is the way to get moisture under the canopy cover of the associated plant for the *P. antidotale*.

It plays a role in sand dune stabilization in areas of low rainfall (Saini *et al.*, 2007). It may be a good source of fodder supply either as hay or silage in the newly colonized areas of the Cholistan desert and can prove a good source of fodder throughout the year if managed properly. At the advent of monsoon and spring, it is among the earliest sprouting desert grass species available for the livestock. The grass is more nutritive at the vegetative stage but after some time lower portions of tillers quickly become very hard thus injuring the grazers and in this way save the plant stubbles for next year's growth. Even after prolonged droughts green plants of *P. antidotale* could be seen in sandy loam soils indicating its eco-physiological potential.

Genetic variation within and among populations is strongly affected by ecological factors (Huff *et al.*, 1998; Kolliker *et al.*, 1998; Hsao and Lee, 1999), and micro-geographic differentiation caused by these factors. Ecological differences among the habitats colonized by a plant species can, therefore, result in the development of ecotypes (Gunter *et al.*, 1996). Moreover, different land-use practices are thought to make a contribution to the genetic differentiation of populations (Poschlod and Jackel, 1993; Poschlod *et al.*, 2000). Defoliation, edaphic and climatic conditions are generally known to cause population differentiation and different types of grassland management can result in the development of ecotypic variants (Sweeney and Danneberger, 1995; Zopfi, 1993).

Many studies focusing on the adaptation and available genetic diversity of perennial grasses in their nearby environments. Morpho-genetic variation was also reported among accessions of *Cymbopogon jawarancusa* (Arshad *et al.*, 1995) and *Sporobolus iocladus* (Arshad *et al.*, 1999) collected from the area. Other studies also highlighted the inherent genetic diversity in *Cenchrus ciliaris* (Arshad *et al.*, 2007) these studies have shown high phenotypic diversity and variability among accessions collected from various habitats of Cholistan. Theunissen (1997) studied various morphological characters and found phenotypic adaptations in *Digitaria eriantha* to severe environmental conditions in South Africa. Tefera *et al.* (1992) calculated genetic correlations among quantitative characters of *Eragrostis tef* (Zuec.) and found 'panicle weight' to be closely associated with 'primary tiller', thus an increase in dry mass production.

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Table 1: Selected accessions of *Panicum antidotale* along with their site name in Cholistan Desert.

Sr.No.	Site Name	Accession Number	Provenance	
			Longitude ºN	Latitude ºE
1	Khiwtal Wala Toba	KH1/6	28.362 ºN	71.505 ºE
2	Moujgarh Fort	MJ1/1	29.016 ºN	72.082 ºE
3	Roda Toba	RD1/1	29.410 ºN	72.402 ºE
4	Roda Toba	RD1/2	29.410 ºN	72.402 ºE
5	Shaheedan Wala Toba	SH2/1	29.375 ºN	72.380 ºE
6	Shaheedan Wala Toba	SH1/1	29.375 ºN	72.380 ºE
7	Moujgarh Fort	MJ1/2	29.016 ºN	72.082 ºE
8	Khokhran Wala Toba	KWT1/1	28.892 ºN	71.774 ºE
9	Derawar Fort	DR1/1	28.768 ºN	71.333 ºE

Wide environmental variation often occurs within the plant species in the Cholistan desert. Adaptations of grass species to this variation may produce different morpho-anatomical characteristics, resulting in the development of ecotypes. Some of the habitats of Cholistan desert depict a fairly good amount of useful and exploitable genetic diversity in different perennial grasses (Rao *et al*., 1989). To explore this hidden genetic stock, the present study was conducted to screen out some high rank genotypes of *P. antidotale* through morpho-anatomical characters and this core collection would be useful for future studies.

MATERIALS AND METHODS

Various grass germplasm collecting expeditions were executed during 2004 and 2005 in various sites of the Cholistan desert (Table 1) and many accessions of *Panicum antidotale* were collected. Because of overgrazing and prolonged droughts the seeds of this grass were not available, consequently the plantlets were uprooted and tagged. Multiple plantlets for all accessions were raised under uniform environmental conditions at the experimental area of the Cholistan Institute of Desert Studies (CIDS), Islamia University, Bahawalpur. The study was replicated three times. Plant to plant and line-to-line distance was maintained as one meter.

The data on eco-physiological characteristics viz. flag leaf area, number of hairs on upper surface of the leaf, number of hairs on lower surface of the leaf, number of epidermal appendages at margins of leaf base, thickness of leaf cuticle, number of stomata on upper surface of the leaf, stomatal index and number of epidermal cells on upper surface of the leaf were recorded. Number of hairs on upper and lower surface of leaf, stomatal index and epidermal appendages at the margins of leaf base were recorded following the methods described by Pereira-Netto *et al.* (1999), Yoshida *et al.* (1976), Kumar and Sen (1985). Principal Component Analysis (SAS, 1987) and correlation coefficient were performed by using Minitab (V. 11.0).

RESULTS AND DISCUSSION

The mean, range and standard deviation for eight quantitative morpho-anatomical characteristics of *Panicum antidotale* calculated, showed considerable variations and the summary statistics for these characters has been presented in Table 2. Maximum variation was found in the number of hairs on lower surface of leaf (SD=28.46) and on

upper surface of leaf (SD=25.74) while the least variation was shown by thickness of leaf cuticle (SD=2.10) and stomatal index (SD=2.36).

Correlation coefficients for different variables are presented in Table 3. Flag leaf area has negative correlation with the number of epidermal appendages at margins of leaf base, thickness of leaf cuticle and stomatal index. Number of hairs on upper surface and lower surface of leaf showed strong correlation with each other but negative correlation with number of epidermal cells on upper surface of leaf. Epidermal appendages at margins of leaf base showed very strong association with thickness of leaf cuticle and number of epidermal cells on upper surface of the leaf. The thickness of leaf cuticle has very high association with the number of stomata on upper surface of leaf and stomatal index. Number of stomata on upper surface of leaf showed very strong and positive correlation with stomatal index and number of epidermal cells on upper surface of the leaf.

Principal Component Analysis (PCA) was performed to identify accession groups having diverse morphologies and suitable for making core collection. The first three principal components cumulatively contributed 77.3%. Based on character loadings (at an absolute value >0.4) on eigenvectors, characters contributing significantly have been identified (Table 4). The 1st principal component accounted for 39.6% of the variation with eight characters being major contributors. The characters contributing most to this variation included ‘Thickness of leaf cuticle, Number of stomata on upper surface of leaf and Stomatal index’. The 2nd and 3rd principal components accounted for 20.9% and 16.8 % variation respectively. Four characters ‘Number of hairs on upper surface of the leaf’, ‘Number of epidermal cells on upper surface of leaf’, ‘Number of epidermal appendages at margins of leaf base’ and ‘Stomatal index’ exhibited strong loadings in second and third principal components.

The components differentiated the accessions into four groups placing them along both sides of the axis (Fig. 1). The accessions of *P. antidotale* collected from

Table 2: Mean values and range of variation of characters analyzed in the investigation.

Variable	Range Min.	Range Max.	Mean	SD
Flag Leaf area (cm)	5.01	25.46	13.24	7.06
No. of hairs on upper surface leaf.	136.00	218.00	175.55	25.74
No. of hairs on lower surface leaf.	110.67	209.67	156.30	28.46
No. of epidermal appendages at margins of leaf base	11.50	29.00	20.78	5.18
Thickness of leaf cuticle (mm).	2.10	7.00	4.35	2.10
No. of stomata on upper surface of leaf	21.67	39.00	32.78	5.58
Stomatal index (%).	13.29	21.28	18.14	2.36
No. of epidermal cells on upper surface of the leaf	127.00	167.33	147.30	13.00

Table 3: Correlation coefficients of different parameters recorded.

	V1	V2	V3	V4	V5	V6	V7
V2	-0.052						
V3	0.225	0.302**					
V4	-0.515**	-0.087	-0.118				
V5	-0.760**	0.045	-0.273*	0.480**			
V6	-0.241*	-0.114	-0.369**	0.155	0.624**		
V7	-0.422**	0.101	-0.273*	-0.061	0.629**	0.837**	
V8	0.186	-0.339**	-0.214	0.421**	0.163	0.495**	-0.059

* and **, significant at p= 0.05 and p= 0.01, respectively

V1= Flag leaf area, V2= Number of hairs on upper surface of the leaf, V3= Number of hairs on lower surface of the leaf, V4= Number of epidermal appendages at margins of leaf base, V5= Thickness of leaf cuticle, V6= Number of stomata on upper surface of leaf, V7= Stomatal index, V8= Number of epidermal cells on upper surface of leaf.

Table 4: Eigenvectors for the first three Principal Components

Character	PC 1	PC 2	PC 3
Cumulative variance	39.6%	60.5%	77.3%
Flag leaf area (cm^2).	-0.389	0.318	0.392
No. of hairs on upper surface of the leaf.	-0.066	-0.545	-0.046
No. of hairs on lower surface of the leaf.	-0.280	-0.246	-0.185
No. of epidermal appendages at margins of leaf base.	0.281	0.188	-0.663
Thickness of leaf cuticle (mm).	0.504	-0.172	-0.154
No. of stomata on upper surface of leaf.	0.467	0.109	0.390
Stomatal index (%).	0.422	-0.279	0.439
No. of epidermal cells on upper surface of leaf.	0.192	0.622	-0.027

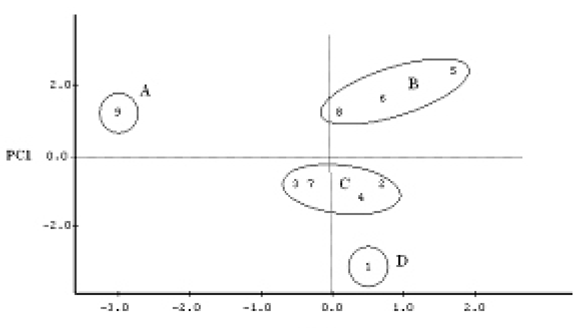

Fig. 1: Plot of principal component 1 and 2 for different accessions of *P. antidotale* Retz

the same location showed notable differences and hence grouped with the accessions of other sites. The characters contributing most to this variation included 'thickness of leaf cuticle, no. of stomata on upper surface of leaf, stomatal index, no. of epidermal cells on upper surface of leaf, no. of hairs on upper surface of the leaf and no. of epidermal appendages at margins of leaf base'.

The accession SH2/1 and SH1/1 collected from "Shaheedan Wala Toba" and KWT1/1 collected from "Khokhran Wala Toba" appeared to be the best with regard to flag leaf area, number of hairs on upper surface of leaf, number of hairs on lower surface of leaf, number of epidermal appendages at margins of leaf base, thickness of leaf cuticle, number of stomata on upper surface of leaf, stomatal index and number of epidermal cells on upper surface of leaf. All the other accessions were scattered very well in the diagram. A similar type of the variation was recorded in the germplasm of *Cymbopogon jwarancusa* and *Sporobolus iocladus* collected from Cholistan desert by Arshad *et al*. (1995; 1999). These results are also in confirmity with the earlier findings of some of the researchers (Huff *et al*., 1998; Kolliker *et al*., 1998; Kubik *et al*., 2001; Massa *et al*., 2001; Reisch *et al*., 2003; Ubi *et al*., 2003; Fjellheim and Rognli, 2005; Casler, 2005) who found considerable variation in the germplasm of different grass species.

CONCLUSION

It is concluded in the present study that the accessions of *Panicum antidotale* numbering SH2/1, SH1/1, collected from "Shaheedan Wala Toba", and KWT1/2 from "Khokhran Wala Toba", appeared as the best one as compared to the other accessions. These accessions should further be tested under a wide range of environmental stresses such as drought, salinity and high temperature, to find stress tolerant ecotypes. These may be propagated for the restoration of degraded rangelands of the Cholistan desert.

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