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Morpho-Anatomical Adaptability Potential of *Lasiurus scindicus*

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Abstract: Morpho-anatomical adaptability potential of fourteen accessions of *Lasiurus scindicus* (Henr.) collected from the Cholistan desert, Pakistan during 2005 was evaluated. Data collected 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 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. The accessions KWT1/1 and KWT1/2, collected from "Khokhran Wala Toba", BC1/2, from "Baghdad Campus", SWT, from "Sulleh Wala Toba", showed high variation and appeared as the best genotypes based on eco-physiological variations detected in this study hence these will aid in making core collections of this grass species. 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: Accession, adaptability potential, *Lasiurus scindicus*, morpho-anatomical, variation and PCA

INTRODUCTION

The Cholistan desert, a stretch of about 2.6 million hectares in southern Punjab province, Pakistan between latitudes 27º42' and 29º45' North and longitudes 69º52′ and 75º24′ East (FAO, 1993). Cholistan is one of the hottest deserts in Pakistan where mean annual rainfall varies from less than 100 mm in the west to 200 mm in the east. Rainfall is usually received during monsoon (July through September) and in winter and spring (January through March) (Arshad *et al*., 2005). Mean minimum and maximum temperatures are 20 and 40ºC, respectively. Temperatures are high in summer and mostly mild in winter with no frost. The mean summer temperature (May-June) is 34ºC with highs exceeding 50ºC. Aridity is one of the most striking features of the Cholistan desert with wet and dry years occurring in clusters (FAO, 1993; Akbar *et al*., 1996). The entire area of this desert is rain dependant for its ground water recharge and drinking water being stored in dug-out ponds (Tobas). Underground water is at the depth of 30-40 m and mostly is brackish having salt concentration 9000-24000 mg/l (FAO, 1993). The soils are either saline or saline-sodic, with pH ranging from 8.2 to 9.6 (Akbar and Arshad, 2000).

Lasiurus scindicus Henr. locally known as Sewan or Gorkha is the most promising palatable perennial grass of the Cholistan desert and is widely distributed on variety of habitats viz. sand dunes, interdunal sandy areas, interdunal clayey area and in saline soils (Rao *et al*., 1989). The habitats in which the populations of *L. scindicus* are located differ to a high degree from each other with regard to ecological factors such as nutrients, salinity and water, just as in the type of land use by grazing. It is a drought resistant grass and can also withstand excessive grazing pressure. It gives high forage production even in very low rainfall (100-250 mm). Despite of adverse biotic factors, a large area of the Cholistan desert is covered by this grass and is found almost in pure stands in some parts of this desert. During unfavourable periods its un-grazed or left-over stubbles become woody and sharp and thus cause mouth injury to the grazers.

Genetic variation within and among populations is strongly affected by ecological factors (Huff *et al*., 1998; Hsao and Lee, 1999), and microgeographic 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 *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 (Zopfi, 1998).

Wide environmental variation often occurs within the natural range lands of Cholistan desert. Adaptations of grass species to this variation may produce different morphological, anatomical and physiological characteristics, resulting in the development of ecotypes. Some of the habitats of Cholistan desert depict a fairly

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good amount of useful and exploitable genetic diversity in different perennial grasses as reported in previous studies (Arshad *et al.*, 1995; Arshad *et al.*, 1999; Arshad *et al.*, 2007; Arshad *et al.*, 2009). Tefera *et al.* (1992) calculated genetic correlations among twelve quantitative characters of *Eragrostis tef* (Zuec.), and found that panicle weight per plant was most closely associated with panicle weight per primary tiller and productivity index, indicating that these characters may be useful in improving the productivity. Genetic variations in various other grass species have been reported by many workers (Kolliker *et al.*, 1998; Reisch *et al.*, 2003; Ubi *et al.*, 2003; Fjellheim and Rognli, 2005; Casler, 2005).

To explore this hidden genetic treasure, the present study was designed to evaluate the morpho-anatomical variations in *L. scindicus* to select some high rank accessions of this nutritious grass species of the area. The best selections will eventually be checked under multiple stresses.

MATERIALS AND METHODS

Grass germplasm collecting expeditions were executed in different ecozones of the Cholistan desert during 2004-2005 and various accessions of *Lasiurus scindicus* Henr. were collected (Table 1). Due to anthropogenic activities and prolonged droughts, the seeds of this grass were not available; consequently the plantlets were uprooted, tagged and transferred at Cholistan Institute of Desert Studies (CIDS), The Islamia University of Bahawalpur. The plant samples of each accession were further sub-divided into ten equal sized plantlets and were grown at the experimental area CIDS where same environmental were available to all plants. The study was replicated three times and plant to plant and line to line distance was maintained as one meter.

The data on morpho-anatomical characters (Table 2) using standard forage grass descriptors (Tyler *et al.*, 1985) were studied when plants approached maturity. Numbers of hairs on upper and lower surface of leaf were counted following Pereira-Netto *et al.* (1999), stomatal index (Yoshida *et al.*, 1976) and epidermal appendages at the margins of leaf base (Kumar and Sen, 1985) were recorded. Principal Component Analysis (PCA) (Anon., 1985) and correlation Coefficient (Tefera *et al.*, 1992) were performed using Minitab for windows © (ver. 11.0).

RESULTS AND DISCUSSION

The mean, range (min. and max.) and standard deviation (SD) for eight distinct variables of *L. scindicus* presented in Table 2 showed considerable variations. Correlation matrix for different variables is presented in Table 3. Flag leaf area of the plant positively and significantly ($p<0.05$) correlated with number of hairs on lower surface of the leaf, and negatively and significantly ($p<0.05$) correlated with thickness of cuticle and number

Table 1: Selected accessions of *Lasiurus scindicus* along with their site name in Cholistan desert

Site No.	Accession	Site Name	Provenance[T1]	
			Latitude	Logitude
1	DG1/2	Dingarh Fort	28° 56′ 31.38″N	71° 50′ 55.03″ E
2	DG1/9	Dingarh Fort	28° 56′ 31.38″ N	71° 50′ 55.03″ E
3	DG1/3	Dingarh Fort	28° 56′ 31.38″ N	71° 50′ 55.03” E
4	SWT1/4	Sulleh Wala Toba	28° 54′ 06.00″ N	71° 28′ 08.00″ E
5	SWT1/2	Sulleh Wala Toba	28° 54′ 06.00″ N	71° 28′ 08.00″ E
6	DR1/1	Derawar Fort	28° 46′ 06.35″ N	71° 19′59.39″ E
7	DR1/2	Derawar Fort	28° 46′ 06.35″ N	71° 19′ 59.39″ E
8	KWT1/1	Khokhran Wala Toba	28° 53′ 32.00″ N	71° 46′ 28.00″ E
9	KWT1/2	Khokhran Wala Toba	28° 53′ 32.00″ N	71° 46′ 28.00″ E
10	CHP1/1	Channan pir Fort	28° 58′ 02.61″ N	71° 42′ 59.00″ E
11	BC 1/2	Baghdad Campus	29° 22′ 47.79″ N	71° 46′ 15.67″ E
12	BC3/6	Baghdad Campus	29° 22′ 47.79″ N	71° 46′ 15.67″ E
13	MW1/4	Mandri Wala	29° 11′ 03.34″ N	71° 51′ 38.57″ E
14	IS1/9	Islamgarh Fort	27° 50′ 44.21″ N	71° 48′ 49.91″ E

of stomata on upper surface of leaf. Number of hairs on upper surface of the leaf positively and highly significantly ($p<0.01$) correlated with number of epidermal cells on upper surface of leaf and negatively and highly significantly ($p<0.01$) with number of stomata on upper surface of leaf and stomatal index. Number of epidermal appendages at the margins of leaf base showed highly significant ($p<0.01$) and negative correlation with thickness of leaf cuticle, number of stomata on upper surface of leaf and number of epidermal cells on upper surface of leaf but negatively and significantly correlated with stomatal index of upper surface of leaf. Thickness of leaf cuticle positively and highly significantly ($p<0.01$) correlated with number of stomata on upper surface of leaf and stomatal index. Number of stomata on upper surface of leaf highly significantly ($p<0.01$) and positively correlated with stomatal index. Stomatal index gave highly significant ($p<0.01$) but negative correlation with number of epidermal cells on upper surface of leaf.

The first four principal components explained 81.6% of the accumulated variation and the relationship of these principal components with the quantitative variables are shown in Table 4. The First Principal Component (PC1) explained 33.5% of the variation and was associated prominently with flag leaf area, number of hairs on upper 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 leaf, stomatal index and number of epidermal cells on upper surface of leaf. The second principal component (PC2) explained 21.9% of variations and was associated prominently with 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, stomatal index and number of epidermal cells on upper surface of leaf. The third principal component (PC3) showed 14.5% of the variations and was mainly associated with flag leaf area, number of hairs on lower surface of the leaf and number of epidermal appendages at the margins of leaf base. The fourth principal component (PC4) explained 11.8% of the variation having prominent variables such as flag leaf area, number of hairs on upper surface of the leaf, thickness of leaf cuticle, number of stomata on upper surface of leaf,

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

Variables	Mean	Range		SD
		Min.	Max.	
Flag leaf area (cm^2)	2.17	1.09	3.25	0.66
Number of hairs on upper surface of the leaf	15.68	60.00	169.30	34.99
Number of hairs on lower surface of the leaf	42.90	58.00	238.00	43.80
Number of epidermal appendages at margins of leaf base	26.69	17.45	35.75	5.24
Thickness of leaf cuticle (µm)	3.65	2.10	6.30	1.23
Number of stomata on upper surface of the leaf	16.24	11.30	22.60	3.17
Stomatal index (%)	11.59	6.61	19.41	3.53
Number of epidermal cells on upper surface of leaf	132.26	83.60	198.60	32.52

Table 3: Correlation coefficients for different variables recorded

	V1	V2	V3	V4	V5	V6	V7
V2,	0.082						
V3,	0.224*	-0.031					
V4,	- 0.011,	-0.035,	0.118				
V5,	- 0.189*	0.071,	-0.159	-0.495**			
V6,	- 0.227*	-0.472**	-0.105	-0.583**	0.362**		
V7,	- 0.162	-0.412**	0.005	-0.200*	0.234**	0.643**	
V8,	0.094	0.266**	- 0.017	-0.231**	-0.048	-0.146	-0.817**

* 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: Correlation coefficients between the first four principal components and the morphological characters

Variables	PC1	PC2	PC3	PC4
Cumulative contribution	33.5%	55.4%	69.9%	81.6%
Flag leaf area (cm2).	0.202	-0.071	-0.655	-0.201
Number of hairs on upper surface of the leaf.	0.321	0.292	0.148	-0.654
Number of hairs on lower surface of the leaf.	0.097	-0.248	-0.625	-0.134
Number of epidermal appendages at margins of leaf base.	0.286	-0.551	0.316	0.027
Thickness of leaf cuticle (mm).	-0.299	0.426	0.051	-0.424
Number of stomata on upper surface of leaf.	-0.522	0.172	-0.181	0.282
Stomatal index (%).	-0.537	-0.274	-0.045	-0.234
Number of epidermal cells on upper surface of leaf.	0.337	0.509	-0.145	0.446

stomatal index and number of epidermal cells on upper surface of leaf.

A plot of accessions drawn against PC1 and PC2 grouped all 14 accessions into four cohesive groups containing 2 to 5 accessions and indicated a high amount of variation among recorded morpho-genetic characters (Fig. 1). Even the accessions of *L. scindicus* collected from the same location showed notable differences in 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 leaf, stomatal index and number of epidermal cells on upper surface of leaf. This difference among accessions of the same habitat is thought due to the fact that on sand dunes fewer nutrients are there as compared to the interdunal tracts. The encroachment of dunes by wind action washed the nutrients and litter and finally deposit it in the interdunal flatter areas thus causing the microhabitat for the species inhabiting the same territory. Heavy monsoon rainfall also aid in this process and trickles the remaining nutrients on dunes to the deeper layers and causing decline in nutrients. The interdunal tracts accumulated maximum nutrients because wind sweeps and deposit the dead organic matter and sand and the individuals inhabiting over it got sufficient nutrients and hence showed better vigor and growth which ultimately results in the morphological variations among the individuals of the same species. With the passage of time these morphological variation become permanent character of the plant thus ecotypic vartiant.

The accessions SWT1/2, BC1/2, KWT1/1 and KWT1/2 appearing as the genetically most diverse but having some similarity trends among them as compared to other accessions and hence falling in the same group (G-IV). This group of accessions ultimately is helpful in making core collections of this grass. These accessions appeared to be the better accessions 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 other accessions are scattered very well in the diagram. Similar kind of the variation was recorded in the germplasm of *Cymbopogon jwarancusa* (Arshad *et al.*, 1995), *Sporobolus iocladus* (Arshad *et al.*, 1999), *Cenchrus ciliaris* (Arshad *et al.*, 2007) and *Lasiurus scindicus* (Arshad *et al.*, 2009) from Cholistan desert. These results are also in confirmity with the findings of Reid *et al.* (1997), Huff *et al.* (1998), Kolliker *et al.* (1998), Kubik *et al.* (2001), Massa *et al.* (2001), Nair and Somarajan (2003) and Bolaric *et al.* (2005).

It is concluded in the present study that the accessions grouped in G-IV (SWT1/2, BC1/2, KWT1/1, KWT1/2) of *L. scindicus*, collected from "Sulleh Wala Toba", "Baghdad Campus" and "Khokhran Wala Toba", appeared as the best one and genetically most diverse and helpful in making core collections. These core collections

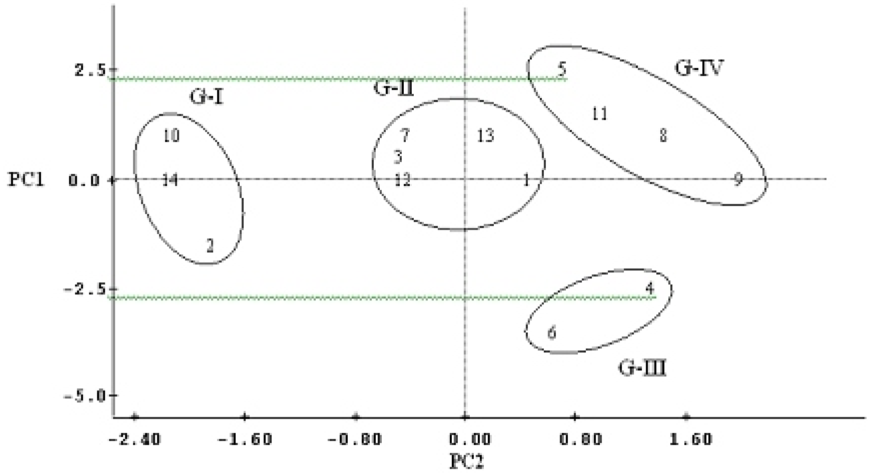

Fig. 1: Plot of principal component 2 and 1 for different accessions of *L. scindicus* collected from Cholistan desert

of this perennial grass should further be tested under a wide range of environmental stresses such as drought, salinity and high temperature, to find stress tolerant genotypes. The evaluated accessions may be propagated for the restoration of degraded rangelands of Cholistan desert which will sustain the wild as well as domestic stock.

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