Pak. J. Bot., 41(3): 1331-1337, 2009.

STUDY ON AGROMORPHOLOGICAL VARIATION IN GERMPLASAM OF *LASIURUS SCINDICUS* FROM CHOLISTAN DESERT, PAKISTAN

MUHAMMAD ARSHAD[1]*, IBRAR HUSSAIN[1], MUHAMMAD YASIN ASHRAF[2], SAJIDA NOUREEN[3] AND MUHAMMAD MUKHTAR[4]

*[1]*Cholistan Institute of Desert Studies, The Islamia University of Bahawalpur, Bahawalpur, Pakistan*
[2]Nuclear Institute of Agriculture and Biology, Jhang Road, Faisalabad, Pakistan
[3]Department of Chemistry, The Islamia University of Bahawalpur, Bahawalpur, Pakistan
[4]Department of Biochemistry, PMAS Arid Agriculture University, Rawalpindi, Pakistan.

Abstract

Agro-morphological variations in 11 accessions of *Lasiurus scindicus* collected from different areas of the Cholistan desert in 2004-2005 were evaluated. The most widely varied variables were number of fertile branches per plant, number of tillers per plant and height of the plant. Considerable range of variation was recorded in number of leaves on main tiller, flag leaf area, length of inflorescence and 4th node leaf area of main tiller, whereas very low variation was noted in number of internodes on main tiller and length of internode covered by leaf sheath at the 4th node of main tiller. The accessions DG1/6 collected from Din Garh Fort area, SWT1/2 collected from Sullah Wala Toba, DR1/2 collected from Derawar Fort area, BLT1/2 collected from Bailah Wala Tibba, KWT1/2 collected from Khokhran Wala Toba and CHP1/1 collected from Channanpir area appeared as the best genotypes based on their agro-morphological variation detected in this study.

Introduction

Genetic variability among plants refers to how different the genetic material is between individuals of the same species (Ashraf, 1994; Ashraf *et al*., 2008). There is greater genetic variability between a seed, planted today and same kind of plant that grew 100 years ago. Ecotypic variation is a common phenomenon in various grass species reflected by the presence of morphological distinctness and specific topographical and habitat preferences (Bosch & Theunissen, 1992). The accessions reflect differently to the different environmental factors, explaining that a species could be classified into different ecological status groups depending on the geographical distribution or habitat condition to which it is associated (Rao *et al*., 1989).

Lasiurus scindicus locally known as “Sewan” is one of the commonest and most promising species in Cholistan desert for forage production. It thrives well in medium and high semi-stabilized sand dunes producing high forage yield and good ground cover, but remains absent from calcareous, hard and flat habitats. It has been regarded as the “king grass” based on its high aerial cover (Rao *et al*., 1989; Anon, 1993). *Lasiurus scindicus* can survive extreme arid condition and remain productive for a period of 6 to 10 years (Rao *et al.*, 1989; Anon., 1993). The grass is very well distributed in the entire area of Cholistan Desert. It is highly xeric, drought tolerant and nutritious grass of this desert at the advent of the monsoon and spring it is among the earliest sprouting grass species available for livestock (Rao *et al*., 1989). After monsoon rainfall, green patches of *Lasiurus scindicus* occur on sand dunes and interdunal sandy areas indicating its eco-physiological potential, excelling other parent grasses (Arshad *et al*., 2007).

[*]E-mail: marshad54@hotmail.com

Its geographical distribution to the varying land spaces viz., dunes, sloppy contours, dry lands and salinity patches of the desert required immediate scientific studies of the endemic ecotypes. Various ecozones of Cholistan Desert depict a fairly good amount of useful and exploitable genetic diversity of *Lasiurus scindicus*. To unearth this hidden genetic treasure, the present study was designed to explore germplasm resource of *Lasiurus scindicus* by screening morphogenetic variations for the selection of some high rank ecotypes of this grass. The best selections will ultimately be checked under multiple stresses.

Materials and Methods

Study site: The Cholistan desert is located in southern Punjab province of Pakistan and is spreading over an area of 26000 km^2 between latitudes 27^o 42' and 29^o 45' North and longitudes 69^o 52' and 75^o 24' East (Anon., 1993; Arshad *et al*., 2007; Noureen *et al.*, 2008). Cholistan is one of the hottest deserts in Pakistan. Mean annual rainfall varies from 100 mm to 200 mm. Rainfall is usually received during the monsoon (July to September) and in winter and spring (January to March) (Arshad *et al*., 2006). Mean minimum and maximum temperatures are 20 and 40^oC, respectively. Temperatures are high in summer and mild in winter with no frost. The mean summer temperature (May to June) is 34^oC with highs exceeding 51^oC (Anon, 1993; Mughal, 1997; Arshad *et al*., 2007). Aridity is one of the most striking features of the Cholistan desert with wet and dry years occurring in clusters. The entire area of this desert is rain dependant for its ground water recharge and drinking water. Rain-water is harvested in low-lying areas or in dug-out ponds locally called as "Tobas". Underground water is at a depth of 25-40 m and is mostly brackish having salt concentration of 9000-24000 mg L^{-1}. The soils are either saline or saline-sodic, with pH ranging from 8.2 to 9.6 (Anon., 1993; Akbar *et al*., 1996; Arshad *et al*., 2007; Arshad *et al.*, 2008).

Vegetation in Cholistan desert is composed of xerophytic species, which are very well adapted to the extreme seasonal temperatures, moisture fluctuations and a wide variety of edaphic conditions. Grasses can survive extremes of environmental conditions like frost, drought, fire and grazing, so they have high reproductive capability and quick dispersal. Important species of perennial grasses found in Cholistan Desert include *Cenchrus ciliaris*, *Lasiurus scindicus*, *Panicum antidotale*, *Panicum turgidum, Stipagrostis plumosa, Cymbopogon jwarancusa*, *Sporobolus ioclados,* A*eluropus lagopoides* and *Ochthochloa compressa* (Arshad *et al*., 2007).

Grass germplasm collection/exploration: For the collection of germplasm of perennial grasses various desert grass germplasm collecting expeditions were executed in different habitats of Cholistan desert and accessions of various perennial grass species, including *Lasiurus scindicus* (Sewan) were collected and propagated at the desert grass germplasm nursery of the Cholistan Institute of Desert Studies (CIDS), The Islamia University of Bahawalpur. For present study 11 accessions of *Lasiurus scindicus* (Table 1) showing contrasting characters were selected and grown under randomized complete block design to explore genetic variabilities with regard to agro-morphological parameters. In order to work out the similarities and dissimilarities among the eleven accessions of *Lasiurus scindicus* and in the 10 agro-morphological characters, the recorded data was analysed by using Principal Component Analysis (Anon., 1985).

Table 1. Accession number along with collection site names and coordinates.

S. No.	Accession number	Site name	Coordinates
1.	DG 1/2	Din Garh Fort	28^o 56’ 37” N 71^o 49’ 36” E
2.	DG1/9	Din Garh Fort	28^o 56’ 37” N 71^o 49’ 36” E
3.	DG1/3	Din Garh Fort	28^o 56’ 37” N 71^o 49’ 36” E
4.	SWT1/4	Sulleh Wala Toba	28^o 54’ 06” N 71^o 28’ 08” E
5.	SWT1/2	Sulleh Wala Toba	28^o 54’ 06” N 71^o 28’ 08” E
6.	DG1/6	Din Garh Fort	28^o 56’ 37” N 71^o 49’ 36” E
7.	DR1/2	Derawar Fort	28^o 46’ 02” N 71^o 20’ 15” E
8.	KWT1/1	Khokhran Wala Toba	28^o 06’ 12” N 71^o 50’ 10” E
9.	KWT1/2	Khokhran Wala Toba	28^o 06’ 12” N 71^o 50’ 10” E
10.	CHP1/1	Channan Pir Wala Tibba	28^o 59’ 56” N 71^o 39’ 55” E
11.	BLT1/2	Bai Lah Wala Tibba	28^o 55’ 10” N 71^o 29’ 05” E

Results and Discussion

High morphological variation was recorded among the 11 accessions of the *Lasiurus scindicus*, collected from different areas of Cholistan Desert. The most widely varied variables were number of fertile branches per plant, number of tillers per plant and height of the plant. Considerable range of variation was also recorded in number of leaves on main tiller, flag leaf area, length of inflorescence and 4th node leaf area of main tiller whereas very low variation was noted in number of internodes on main tiller and length of internode covered by leaf sheath at the 4th node of main tiller (Table 2).

Correlation coefficients for agro-morphological traits given in Table 3 showed that height of the plant positively and highly significantly ($p<0.01$) correlated with number of fertile branches per plant, flag leaf area, number of leaves on main tiller, number of internodes on main tiller and length of the internode covered by leaf sheath at the 4th node of main tiller and significantly ($p<0.05$) with the number of tillers per plant. Number of tillers per plant correlated positively and highly significantly ($p<0.01$) with number of fertile branches per plant, number of internodes on main tiller and thickness of the stem at 4th node of the main tiller and significantly ($p<0.05$) with length of the internode covered by leaf sheath at the 4th node of main tiller. Positive and highly significant ($p<0.01$) correlation was recorded among number of fertile branches per plant, number of internodes on main tiller, thickness of stem at 4th node of main tiller and length of internode covered by leaf sheath at the 4th node of main tiller.

Length of inflorescence negatively and highly significantly ($p<0.01$) correlated with the 4th node leaf area of the main tiller and positively and highly significantly ($p<0.01$) with number of leaves on main tiller and significantly ($p<0.05$) with length of internode covered by leaf sheath. Flag leaf area positively and highly significantly ($p<0.01$) correlated with number of leaves on main tiller and length of internode covered by leaf sheath. Negative and highly significant ($p<0.01$) correlation was recorded among the 4th node leaf area of main tiller and number of leaves on main tiller and positive and highly significant ($p<0.01$) correlation with thickness of the stem at the 4th node of main tiller. Number of leaves on main tiller positively and highly significantly ($p<0.01$) correlated with length of internode covered by leaf sheath at the 4th node of main tiller. Thickness of stem at 4th node of main tiller positively and highly significantly ($p<0.01$) correlated with length of internode covered by leaf sheath at the 4th node of main tiller.

The latent roots, percentage variance and cumulative variance in various principal components are given in Table 4. The first five principal components explained 94.7 % of the total variance.

Table 2. Mean and range of variations of 10 quantitative characters recorded in 11 accessions of *Lasiurus scindicus*.

S. No.	Variables	Mean + SE	Standard deviation	Range
1.	Height of the plant (cm)	99.33 + 3.45	11.45	85.00 - 124.90
2.	Number of tillers per plant	24.34 + 6.01	19.91	04.70 - 78.20
3.	Number of fertile branches per plant	95.70 + 24.10	80.00	09.70 - 301.80
4.	Length of inflorescence (cm)	08.46 + 0.34	1.12	06.80 - 10.80
5.	Flag leaf area (cm^2)	01.50 + 0.12	0.40	00.90 - 2.21
6.	4^{th} node leaf area of main tiller (cm^2)	04.15 + 0.36	1.22	02.13 - 6.22
7.	Number of leaves on main tiller	11.10 + 0.81	2.69	07.70 - 18.20
8.	Number of internodes on main tiller	06.54 + 0.27	0.90	04.80 - 7.83
9.	Thickness of stem at 4^{th} node of main tiller	03.86 + 0.36	0.40	03.20 - 4.53
10.	Length of internode covered by leaf sheath at the 4^{th} node of main tiller (cm)	05.55 + 0.22	0.74	04.30 - 6.88

Table 3. Correlation coefficients for morphological traits.

	V1	V2	V3	V4	V5	V6	V7	V8	V9
V2	**0.397***								
V3	**0.476****	**0.990****							
V4	0.064	0.232	0.289						
V5	**0.363****	0.041	0.064	0.080					
V6	0.181	0.111	0.196	**0.722****	-0.245				
V7	**0.505****	0.167	0.185	**-0.377****	**0.702****	**-0.354****			
V8	**0.751****	**0.595****	**0.678****	0.274	0.194	0.235	0.183		
V9	0.096	**0.386****	**0.381****	-0.002	-0.275	**0.357****	0.007	0.011	
V10	**0.514****	**0.328***	**0.363****	**0.304***	**0.575****	0.184	**0.503****	0.193	**0.357****

*and **, significance at P = 0.05 and P = 0.01, respectively.

V1=Height of the plant, V2=Number of tillers per plant, V3=Number of fertile branches per plant, V4=Length of inflorescence, V5=Flag leaf area, V6=4^{th} node leaf area of main tiller, V7=Number of leaves on main tiller, V8=Number of internodes on main tiller, V9=Thickness of stem at 4^{th} node of main tiller, V10=Length of internode covered by leaf sheath at the 4^{th} node of main tiller.

Table 4. Latent roots, percent variance and cumulative variance in various principal components.

Principal components	Latent roots	Percentage variance	Cumulative variance
PC1	3.73	37.3	37.3
PC2	2.39	23.9	61.2
PC3	1.40	14.1	75.3
PC4	1.19	11.9	87.2
PC5	0.74	07.5	94.7

The relationship of these principal components with the quantitative variables is given in Table 5. The variables prominent in first principal component (PC1) were height of the plant, number of tillers per plant, number of fertile branches per plant, number of internodes on main tiller and length of internode covered by leaf sheath at the 4^{th} node of main tiller. The variables significant in second principal component (PC2) were length of inflorescence, flag leaf area, 4^{th} node leaf area of main tiller and number of leaves on main tiller. In the third principal component (PC3), number of tillers per plant, number of fertile branches per plant, length of inflorescence, flag leaf area and 4^{th} node leaf area of main tiller were prominent. The variables significant in the fourth principal component (PC4) were number of internodes on main tiller, thickness of stem at 4^{th} node of main tiller and length of internode covered by leaf sheath at the 4^{th} node of main tiller. The variables significant in the fifth principal component (PC5) were height of the plant, number of tillers per plant, length of inflorescence and 4^{th} node leaf area of main tiller.

Table 5. Eigenvectors for the first five principal components.

Variables	PC1	PC2	PC3	PC4	PC5
Height of the plant	**-0.404**	0.156	0.056	-0.159	**0.578**
Number of tillers per plant	**-0.413**	-0.136	**-0.366**	-0.067	**-0.391**
Number of fertile branches per plant	**-0.443**	-0.147	**-0.307**	-0.094	-0.299
Length of inflorescence	-0.187	**-0.382**	**0.542**	-0.101	**-0.325**
Flag leaf area	-0.204	**0.459**	**0.390**	0.000	-0.281
4^{th} node leaf area of main tiller	-0.159	**-0.472**	**0.376**	0.127	**0.330**
Number of leaves on main tiller	-0.228	**0.524**	-0.031	0.171	0.092
Number of internodes on main tiller	**-0.398**	-0.049	-0.054	**-0.485**	0.273
Thickness of stem at 4^{th} node of main tiller	-0.182	-0.237	-0.294	**0.676**	0.190
Length of internode covered by leaf sheath at the 4^{th} node of main tiller	**-0.353**	0.153	0.302	**0.462**	-0.107

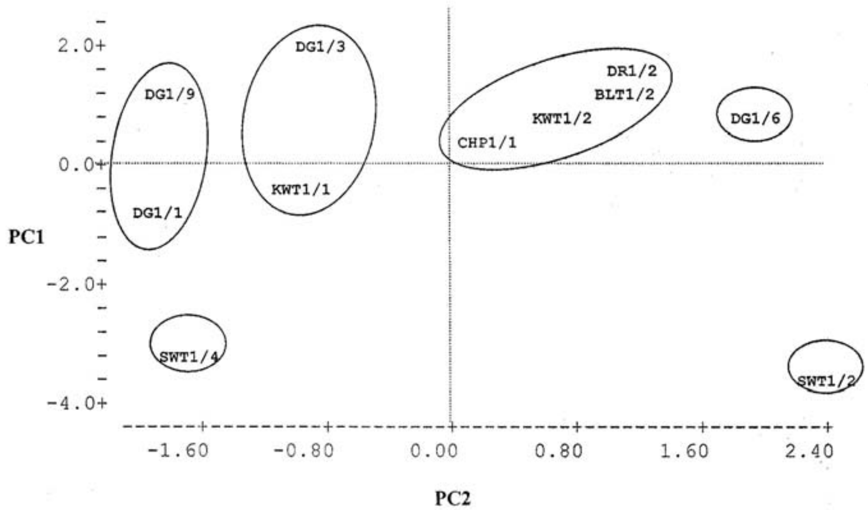

Fig. 1. Plot of principal component 1 and 2 for different accessions of *Lasiurus scindicus.*

A plot of accessions drawn against PC1 and PC2 grouped all the 11 accessions of *Lasiurus scindicus* into six cohesive groups containing 1 to 4 accessions and indicated a high amount of variation among the recorded agro-morphological characters (Fig. 1).

Even the samples collected from the plants of same location showed notable differences in height of the plant, number of tillers per plant, number of fertile branches per plant, number of internodes on main tiller, length of internode covered by leaf sheath at the 4^{th} node of main tiller, length of inflorescence, flag leaf area and 4^{th} node leaf area of the main tiller.

The accessions SWT1/2, SWT1/4, collected from Sullah Wala Toba and DG1/9 and DG1/6 collected from Din Garh Fort area were widely scattered in the plot. The accessions DG1/6 collected from Din Garh Fort area, SWT1/2 collected from Sullah Wala Toba, DR1/2 collected from Derawar Fort area, BLT1/2 collected from Bailah Wala Tibba, KWT1/2 collected from Khokhran Wala Toba and CHP1/1 collected from Channanpir area appeared as the best accessions with regard to the height of the plant, number of tillers per plant, number of fertile branches per plant, number of internodes on main tiller, length of internode covered by leaf sheath, length of inflorescence, flag leaf area and 4^{th} node leaf area of the main tiller.

The results of present study are similar as were reported by Arshad *et al*., (1995, 1999 & 2007) on exploring the germplasm of *Cymbopogan jwarancusa, Sporobolus ioclados* and *Cenchrus ciliaris*, respectively, collected from different areas of Cholistan Desert. Nair & Somarajan, (2003) reported same results on exploring the genetic diversity of *Saccharum spontaneum* in Kerala, India. Quinn & Wetherington, (2001) on evaluation of genetic variability in *Panicum virgatum* and *Sporobolus cryptandrus* also reported similar results. The findings of present study are also in conformity with the results of Ayana & Bekele, (1999) who grouped 415 *Sorghum* accessions collected from Ethiopia and Eritrea. The studies conducted by But *et al*., (1990); Agarwal *et al*., (1999); Ojeda *et al*., (2001); Brandolini & Brandolini, (2001); Assefa *et al*., (2001) and Frese *et al*., (2001) also reported the similar results.

The results achieved in this study leads to conclude that the germplasm of *Lasiurus scindicus* collected from different areas of Cholistan desert displayed considerable agro-morphological variations in height of the plant, number of tillers per plant, number of fertile branches per plant, number of internodes on main tiller, length of internode covered by leaf sheath at the 4^{th} node of main tiller, length of inflorescence, flag leaf area and 4^{th} node leaf area of the main tiller. The high performing accessions of *Lasiurus scindicus* screened in this study should further be evaluated under a wide range of stresses including drought, salinity and high temperature, to find stress tolerant genotypes. These accessions may also be propagated to check their adaptability potential in their original habitats in Cholistan desert and to increase the productivity of degraded rangelands of the area.

References

Agarwal, D.K., S. Gupta, A.K. Roy and S.R Gupta. 1999. Study on agromorphological variation vis-à-vis geographical distribution in marvel grass (*Dichanthium annulatum* L.). *Plant Gen. Res. Newslet.*, 118: 27-29.

Akbar, G., T.N. Khan and M. Arshad. 1996. Cholistan Desert Pakistan. *Rangelands*, 18: 124-128.

Akhter, R. and M. Arshad. 2006. Arid rangelands in Cholistan desert (Pakistan). *Secheresse*, 17(1-2): 1-8.

Anonymous. 1985. *SAS User's Guide: Statistics*, Ver. 5, Cary, North Carolina.

Anonymous. 1993. *Pakistan–Cholistan Area Development Project*. Report No. 59/53 ADB-PAK 58 (Final version). Food and Agriculture Organization of the United Nations, Rome.

Arshad, M., A. Hassan, M.Y. Ashraf, S. Noureen and M. Moazzam. 2008. Edaphic factors and distribution of vegetation in the Cholistan desert, Pakistan. *Pak. J. Bot.,* 40(5): 1923-1831.

Arshad, M., A.R. Rao, G. Akbar and M. Akhtar. 1999. Eco-physiological adaptability potential of *Sporobolus ioclados* in Cholistan Desert. *Pak. J. Biol. Sci.,* 2(4): 1604-1607.

Arshad, M., A.R. Rao, M. Akhtar and G. Akbar. 1995. Potential genetic adaptability of *Cymbopogan jwarancusa* (Jones) Schult, from Cholistan Desert, Pakistan. *Sarhad J. Agric.,* 11(1): 63-69.

Arshad, M., M. Ashraf and N. Arif. 2006. Morphological variability of *Prosopis cineraria* (L.) Druce, from the Cholistan desert, Pakistan. *Gen. Res. Crop Evol.,* 53(8): 1589-1596.

Arshad, M., M.Y. Ashraf, M. Ahmad and F. Zaman. 2007. Morpho-genetic variability potential of *Cenchrus ciliaris* L. from Cholistan desert, Pakistan. *Pak. J. Bot*., 39(5): 1481-1488.

Ashraf, M. 1994. Breeding for salinity tolerance in plants. *Crit. Rev. Plant Sci.,* 13: 17-42.

Ashraf, M., H.R. Athar, P.J.C. Harris and T.R. Kwon. 2008. Some prospective strategies for improving crop salt tolerance. *Adv. Agron.,* 97: 45-110.

Assefa, K., H. Tefera, A. Merker, T. Kefyalew and F. Hundera. 2001. Quantitative trait diversity in *tef [Eragrostis tef (Zucc.) Trotter]* germplasm from Central and Northern Ethiopia. *Gen. Res. Crop Evol*., 48(1): 53-61.

Ayana, A. and E. Bekele. 1999. Multivariate analysis of morphological variation in *Sorghum (Sorghum bicolor (L.) Moench)* germplasm from Ethiopia and Eritrea. *Gen. Res. Crop Evol.,* 46(3): 273-284.

Bosch, O.J.H. and J.D. Theunissen. 1992. Differences in response of species on the degradation gradient in the semi-arid grasslands of Southern Africa and role of genetic variation. In: *Desertified Grasslands: Their Biology and Management*. (Ed.): G.D. Chapman. The Linnean Society of London. pp. 95

Brandolini, A. and A. Brandolini. 2001. Classification of Italian maize (*Zea Mays* L.) germplasm. *Plant Gen. Res. Newslet.,* 126: 1-11.

But, N.M., N. Muhammad, Sartaj and M.I. Sultani. 1999. Performance of tropical grasses under subhumid-subtropical conditions of Pakistan. *Pak. J. For.,* 318-320.

Frese, L., Z. Akbarov, V.I. Burenin, M.N. Arjmand and V. Hajiyev. 2001. Plant exploration in the Talysch Mountains of Azarbijan and Iran. *Plant gen. Res. Newslet*., 126: 1-11.

Mughal, M.R. 1997. *Ancient Cholistan-archaeology and Architecture*. Ferosons (Pvt.) Ltd. Lahore. Pp. 21.

Nair. N.V. and K.G. Somarajan. 2003. Diversity of *Saccharum* germplasm in Kerala, India. *Plant Gen. Res. Newslet.,* 135: 40-43.

Noureen, S., M. Arshad, K. Mahmood and M.Y. Ashraf. 2008. Improvement in fertility of nutritionally poor sandy soils of Cholistan desert, Pakistan by *Calligonum polygonoides* Linn. *Pak. J. Bot.,* 40(1): 265-274.

Ojeda, M., R. Coirini, J. Cosiansi, R. Zapata and Y.J. Zygadlo. 2001. Evaluatiuon of variability in natural populations of *Peperina* (*Minthostachys mollis* (Kunth) Griseb.), an aromatic species from Argentina. *Plant Gen. Res. Newslet.,* 126: 1-11.

Quinn, J.A. and J.D. Wetherington. 2001. Genetic variability and phenotypic plasticity in flowering phenology in populations of two grasses (*Sporobolus cryptandrus* and *Panicum virgatum*), from New Jersey. *J. Torrey Bot. Soc.,* 129(2): 96-106.

Rao, A.R., M. Arshad and M. Shafiq. 1989. *Perennial grasses germplasm of Cholistan desert and its phytosociology*. Cholistan Institute of Desert Studies, Islamia University, Bahawalpur, pp. 162.

(Received for publication 20 March, 2008)