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Eco-physiological Adaptability Potential of *Sporobolus iocladus* in Cholistan Desert

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Abstract
The inherent genetic potential of four ecotypes of a perennial grass *Sporobolus iocladus*, collected from four habitats of Cholistan desert, showed considerably high genetic variation with regard to morphological characters recorded. Ecotype 4 from "Shaheedan Wala Toba" and ecotype 1 from "Lal Suhanra" appeared to be the best thriving ones with respect to leaf area, number of tillers per plant, fresh weight of plant and number of leaves per tiller. Positive correlations among various morphological variables indicate that selected ecotypes may eventually prove highly desirable for enhancing biomass production and restoration of plant cover in saline 'dahars' in degraded rangelands of Cholistan.

Introduction
Cholistan desert covering an area of about 26,000 km^2 lies in the south of the Punjab. Average annual rainfall of this desert varies from 100-250 mm, falling mostly from July to September. Maximum and minimum temperatures are around 50°C in summer and 10°C in winter (Akbar *et al.*, 1996; Akram *et al.*, 1990).

Sporobolus iocladus (Poaceae) locally called as 'Sawarri" is a xeric grass found in Cholistan desert enduring the severest and prolonged droughts and temperatures. Its resistance against high soil salinity and over-grazing is also far better than most of the other endemic perennial grasses. It is a characteristic halophyte but is still liked by the cattle. With the onset of monsoon rains, its old perennating rootstocks start sprouting and provide good fodder, however with the termination of rainy season, its aerial parts start drying up after seed formation.

Sporobolus iocladus is is very well distributed in different climatic zones of southern Asia including the semi-deserts of Pakistan. It is one of the nine hardiest perennial grasses of Cholistan desert thriving and colonizing highly alkaline/sodic soils with enormous competiting potential (Rao and Arshad, 1991). In saline depressions of Indian desert a forage yield 424 kgha^{-1} of this grass has been obtained by Shankar and Kumar (1987). It has been reported by Sen and Muhammad (1994) that salt is accumulated in the leaves of *Sporobolus iocladus* and is profusely secreted out from their upper surface.

Bosch and Theunissen (1992) reported that ecotypic variation is a common phenomenon in various grass species reflected by the presence of morphological distinctness and specific topographical and habitat preferences. The ecotypes react differently to different environmental factors, explaining that a species could be classified into different ecological status groups, depending on geographical distribution or habitat condition to which it is associated. Muhammad (1991) determined comparative performance of ten ecotypes of *Cenchrus ciliaris* under rainfed (barani) conditions and recorded significant variations with regard to yield. Arshad *et al.*, (1995) evaluated inherent genetic variability among thirty two ecotypes of *Cymbopogon jwarancusa*, collected from various habitats of Cholistan desert and found that all of them showed considerably high genetic variability with regard to the morphological characters and a few of them were superior in many respects..

As expected some of the habitats of Cholistan desert are richer and depict a fairly good amount of useful and exploitable genetic variability of *Sporobolus iocladus*. To unearth this hidden genetic treasure, the present study was designed to build its germplasm resource and select some superior ecotypes of this grass under limited water supply. The best selections will ultimately be introduced and tried in different habitats deep in Cholistan desert. It was creditable to observe that geographical distribution of this grass through seed dispersal is much more efficient and faster than the other associated perennial grasses, thus stands a good chance to green the degraded parts of desert and curtail the desertification.

Materials and Methods.
Cholistan Institute of Desert Studies, (CIDS), Islamia University Bahawalpur, collected perennial desert grasses including given below the four promising variants/ecotypes of *Sporobolus iocladus* from different habitats of Cholistan desert and were propagated at the experimental area of CIDS. These four ecotypes were selected after some critical field observations as they exhibited some morphologically important diagnostic features and highre forage yield.

No. of ecotypes	Collection number	Name of site (desert)
E1	LS3/6	Lal Suhanra
E2	SH1/5	Shaheedan WalaToba
E3	YZ1/2	Desert of Chack 43/D.B Yazman
E4	SH2/11	Shaheedan Wala Toba

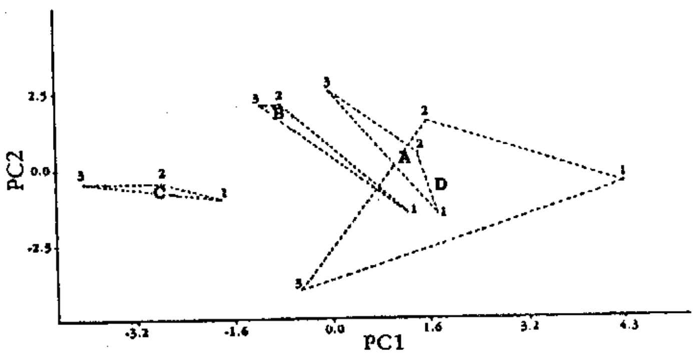

Fig. 1: Group of locations/collection sites in Principal Component 2 and 1

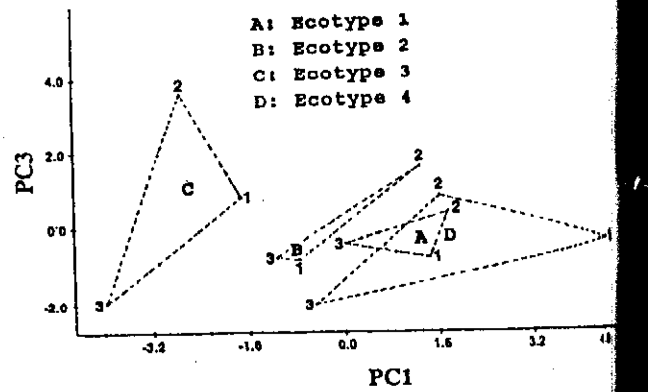

Fig. 2: Group of locations/collection sites in Principal Component 3 and 1.

Healthy stools of above four ecotypes were uprooted and sub-divided into six equal-sized plantlets and were planted at the experimental area. The experiment was replicated thrice. Plant to plant and line to line distance was one meter. The field conditions of experimental area were almost the same as that of Cholistan desert except that very limited amount of water was applied to the plantlets during first month of their growth for quick establishment. When the new plants were six months old, data on quantitative morphological characters were recorded. In order to work out the similarities and dissimilarities among the four ecotypes in the 17 characters Principal Component Analysis (PCA) was performed (SAS, 1985).

Results and Discussion:

The percentage variance of first four Principal Components (PC 1, PC 2, PC 3 and PC 4) is given in Table 1, accounting for 88 per cent of the total variance. The relationship of first four Principal Components with the quantitative variables are shown in Table 2. The variables prominent in first Principal Component (PC 1) were: number of panicles per plant, number of panicles on main tiller, number of tillers per plant, number of spikelets on first point of panicle, fresh weight of the plant, number of spikelets per panicle and leaf area. In the second Principal Component (PC 2), length of panicle, height of plant, leaf area, number of internodes on main tiller, part of internode covered by leaf sheath and number of leaves on main tiller were prominent. While the days taken to maturity, number of leaves on main tiller, number of internodes on main tiller, number of branches on main tiller and days taken to earing of panicle are prominant characters of third Principal Component (PC 3). The significant variables in fourth Principal Component (PC 4) were: days taken to sprouting, part of internode covered by leaf sheath, days taken to earing of panicle, length of panicle and days to taken to earing of tiller.

The plot of ecotypes drawn against PC2 vs PC1 and PC3 vs PC1 shown in Fig. 1 and Fig. 2 indicates that a high amount of genetic variation exists among the morphological characters. Even the plants collected from same habitats/location (E2 and E4) showed vivid differences in leaf area, number of panicles on main tiller, number of tillers per plant, fresh weight of plant, number of branches on main tiller and number of leaves on main tiller. Similar results were obtained by Uresk (1990) by using multivariate analysis. In his study he delineated ecological stages on mixed grass prairie in Western South Dakota and analyzed 47 variables for 48 sites ranging from potential vegetation to early seral stages.

Table 1: Latent roots, percentage variance and cumulativ variance in various principal components.

Principal Components	Latent roots	Percentage variance	Cumulativ variance
PRIN 1	5.5012	32.4	32.4
PRIN 2	3.6150	21.3	53.6
PRIN 3	2.5844	15.2	68.8
PRIN 4	1.7938	10.6	79.4

Correlation Among Characters: Correlations amo seventeen morphological characters of *Sporobolus iocla* is given in Fig. 3. Days taken to sprouting showed positive correlation with days taken to earing of tille (P<0.01). Similar correlation was found in days taken earing of panicle and days taken to maturity. Number leaves on main tiller indicated a positive and hig significant correlation (P<0.001) with number of branch able 2: Latent vectors of variables in principal components

ariables	PC1	PC2	PC3	PC4
ays to sprouting	0.015	0.241	-0.100	0.457
ays to earing of tillers	-0.097	0.245	-0.212	0.253
ays to earing of panicle	-0.244	0.087	-0.287	-0.347
ays to maturity	-0.211	-0.086	-0.468	-0.235
o.of leaves onmain tiller	0.160	-0.276	-0.416	0.143
o. of internodes on main tiller	0.034	-0.314	-0.358	0.058
ght of plant	0.146	-0.367	0.179	-0.223
rt ofinternode covered by leaf sheath	0.055	-0.311	0.227	0.445
o. of branches on main tiller	0.236	-0.232	-0.344	0.071
o. of tillers per plant	0.367	-0.105	0.118	-0.182
af area	-0.251	-0.360	0.113	0.006
o. of panicles per plant	0.382	-0.044	0.086	-0.185
esh weight of plant (yield)	0.302	-0.115	0.218	-0.124
o. of spikelets on first point of panicle	-0.359	-0.203	0.062	0.004
o. of spikelets per panicle	-0.271	-0.202	0.177	-0.190
ngth of panicle	-0.075	-0.378	0.012	0.357
o. of panicles on main tiller	0.370	-0.161	-0.152	-0.167

C = 0.015 V1 + - 0.097 V2 + - 0.244 V3 + - 0.211 V4 + 0.160 V5 + 0.034 V6 + - 0.146 V7 + 0.055 V8 + 0.236 V9 + 0.367 V10 + 0.251 V11 + 0.382 V12 + 0.305 V13 + -0.359 V14 + - 0.271 V15 + - 0.075 V16 + 0.370 V17.

ote: V = Variable)

main stem and significant correlation ($P<0.01$) with mber of internodes on main tiller and number of panicles main tiller. Days taken to earing by tillers, days taken to aturity and number of internodes on main tiller showed no sitive correlation with any of the characters. Height of e plant indicated a positive and highly significant rrelation ($p<0.001$) with three characters i.e., leaf area, mber of spiklets on first point of panicle and number of iklets per panicle. Part of the internode covered by leaf eath correlated significantly ($P<0.01$) with length of the nicle. The number of branches on main tiller showed a ghly significant and positive correlation ($p<0.001$) with mber of panicles per plant, fresh weight of the plant and mber of panicles on main tiller. Leaf area correlated gnificantly ($p<0.01$) with number of spikelets per panicle d with the length of panicle. While number of panicles r plant showed highly significant correlation ($p<0.001$) th fresh weight of plant and number of panicles on main ers. Fresh weight of plant also showed significant and sitive correlation ($P<0.05$) with number of panicles on ain tiller. Similarly number of spikelets on first point of nicle depicted highly significant correlation with number spikelets per panicle. Tefera *et al.* (1992) calculated netic correlations among twelve quantitative characters *Eragrositis tef* (Zuec) and found that panicle weight per nt was most closely associated with panicle weight per mary tiller and productivity index, indicating that these aracters may be useful in improving the productivity.

is evident from Fig. 1 and Fig. 2 that ecotype 4 from haheedan Wala Toba" and 1 from "Lal Suhanra" appears be the best ones for vegetative growth and may entually prove suitable for future grass development

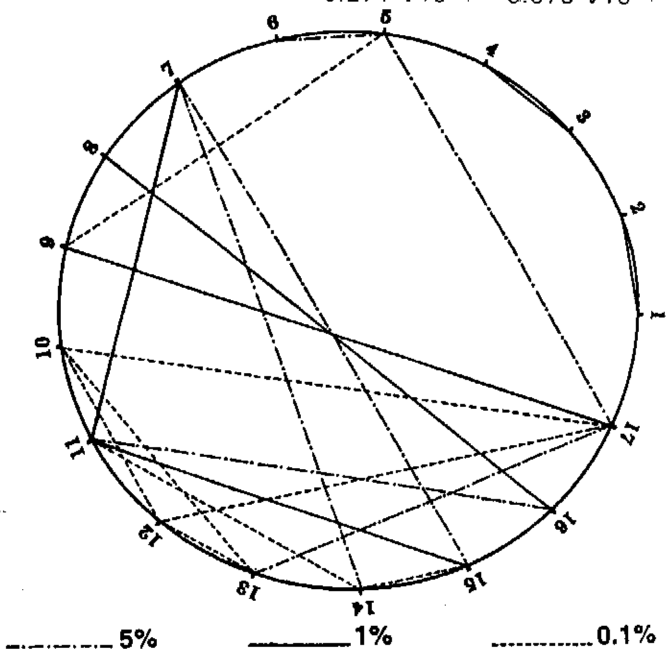

Fig. 3: Correlogram among seventeen characters of *sporobolus iocladus* 1. Days taken to sprouting. 2. Days taken to earing of tillers 3. Days taken to earing of panicle 4. Days takento maturity. 5. Number of leaves on main tiller. 6. Number of internodes on main tiller. 7. Height of the plant. 8. Part of leaf node covered by leaf sheath. 9. Number of branches on main tiller. 10. Number of tillers per plant. 11. Leaf area. 12. Number of panicles per plant. 13. Fresh weight of the plant. 14. Number of spiklets on first point of panicle. 15. Number of spiklets per panicle. 16. Length of the panicle. 17. Number of panicles on main tiller.

programmes in the saline 'dahars' of Cholistan desert. The reason for the relatively growth of these genotypes may be due to their excellent inherent eco-physiological adaptability potential. Positive correlation among various morphological and physiological characters also helped in concluding that these ecotypes of *Sporobolus iocladus* may eventually prove highly valuable strains for the per unit increase of biomass in highly degraded and saline lands of Cholistan desert. To check their productivity potential in desert environment further experimentation/trials are badly needed.

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