Principal Component Analysis in Guinea Grass (*Panicum maximum* Jacq.) Germplasm

Abha Jain, AK Roy, P Kaushal, DR Malaviya and SN Zadoo
Crop Improvement Division, Indian Grassland and Fodder Research Institute, Jhansi-284 003, Uttar Pradesh.

Principal component analysis was carried out using morphological traits in 63 germplasm accessions of *Panicum. maximum* Jacq. The analysis resulted in identification of seven clusters. The largest cluster had 19 accessions followed by clusters with 14 and 10 accessions. Average distance of cluster members from cluster centroids was found to range from 1.543 to 2.695. Many of the clusters comprised entries from as diverse sources as humid Southern India to dry Africa. The study indicated that opportunities exist to select the most desirable type for any agro-ecological zone out of the wide genetic diversity available.

Key Words: Guinea grass, *Panicum maximum*, Germplasm, Cluster, Principal component analysis

The genus *Panicum* of tribe Panicoideae (Family Poaceae/ Graminae) comprises about 500 species distributed in tropical parts of the world. *Panicum maximum* Jacq. popularly known as guinea grass is an important pasture grass. It is adapted and cultivated in many countries because of its high yield, nutritious fodder and tolerance to saline and shade conditions. Guinea grass is native to Africa particularly east Africa, Kenya and Tanzania where wide genetic diversity exists. The crop has been introduced and exploited as a good quality, high yielding fodder particularly in tropical and sub tropical parts of the globe.

In India, initially *P. maximum* var. Makuni was introduced from Australia followed by a number of varieties like 'Hamil', 'Riversdale' and 'Gatton Panic'. (Malaviya, 1996). Indian Grassland and Fodder Research Institute, Jhansi has collected wide genetic diversity of the crop through exploration and introduction of exotic germplasm.

Earlier studies have also reported wide genetic diversity for yield and yield attributing characters in Guinea grass (Burton *et al.*, 1973, Ramaswamy and Raman, 1971, Judd, 1974, Thomas, 1975, Sidak *et al.*, 1977). However, most of the studies were related to the yield contributing characters and the correlation of such traits. Very few attempts were made to group different accessions based on their similarity. In a Japanese study similar to the present one, 119 accessions were clustered into 11 groups based on principal component analysis (Nakajima *et al.*, 1978). Wide diversity was observed in several germplasm lines collected from different parts of India that were put into seven groups on the basis of morphological traits especially qualitative traits (Malaviya, 1996, 1998, Kaushal *et al.*, 1999). The present study aimed at grouping diverse germplasm lines for exploitation in genetic improvement programme.

Materials and Methods

Sixty-three germplasm lines of *P. maximum* were used in the study (Table 1). The healthy seeds of different accessions were sown in the second and the third week of June 1999 and one month old seedlings were transplanted to field at row to row distance of 75 cm and plant to plant distance of 50 cm. Observations on metric traits such as plant height, stem diameter, leaf length, leaf width, flag leaf length, flag leaf width, flag leaf sheath length, peduncle length and inflorescence length were recorded at 50% flowering stage. The observations were recorded on 3 plants selected at random. The data was analyzed statistically using Principal Component Analysis using Euclidean distances. The computation was done using the computer software SPAR1.

Results

The principal component analysis based on 9 morphological traits indicated that the first three components account for 62.11% of total estimated variation. Separate percentages of variations attributable to the first 8 components by decreasing order were 26.22 – 20.27 – 15.62 – 11.22 – 9.75 – 6.14 – 4.77 – 3.92 (Table 3). In the present study, 8 principal components were used in the subsequent cluster analysis which accounted for 97.9 % of the observed variation. The analysis resulted in grouping of 63 germplasm accessions into seven clusters on the basis of their relative similarity/ variation (Table 1).

Nineteen accessions were included in cluster-3 while 14 accessions were clustered in cluster-1 and 10 accessions were observed in cluster-7. In cluster-2 and cluster-5,

seven accessions each were included while three accessions each were clustered in cluster-4 and cluster-6.

Maximum values for morphological traits like plant height, flag leaf length, flag leaf width and inflorescence length were observed in cluster 6. The average leaf length was maximum in cluster-4 and minimum in cluster-5, while leaf width was maximum in cluster-2 and minimum in cluster-3. Maximum flag leaf width was recorded in cluster-6 and minimum in cluster-3. Average and standard deviation of 7 clusters for 9 characters are given in Table 2.

The maximum distance between cluster centroids was observed in cluster-5 and cluster 6 and the cluster-1 and cluster-3 were closest. Average distance between respective cluster members and cluster centroids in different clusters ranged from 1.543 - 2.695. Distances between cluster centroids are given in Table 4.

Table 1. Clustering of genotypes from different geographical regions based on morphological characters.

Cluster number	Geographical region of collections and accession number			
	Ethiopia	India		
		South	North	Central Plains	North East Hills
1	IG 97-32, IG 97-05, IG 97-14	IG 01-96, IG 01-155, IG 01-218, IG 01-169, IG 01-216, IG 01-204, IG 01-82, IG 01-152, IG 01-206.	IG 01-134	IG 01-224	–
2	IG 97-35, IG 97-27	IG 01-121, IG 01-196, IG 01-200, IG 96-241, IG 96-240	–	–	–
3	IG 97-48, IG 97-41	IG 01-221, IG 01-166, IG 01-116, IG 01-93, IG 01-176, IG 01-89, IG 01-119, IG 01-106, IG 01-90, IG 01-151, IG 01-170, IG 01-210	IG 01-183, IG 01-180	IG 01-227, IG 01-229	IG 01-101
4	–	IG 01-171, IG 01-191	IG 01-83	–	–
5	IG 97-08, IG 97-17, IG 97-06, IG 97-22	IG 01-160, IG 01-122, IG 01-188	–	–	–
6	–	IG 01-126, IG 01-205, IG 01-198	–	–	–
7	IG 97-04, IG 97-48-1	IG 01-173, IG 01-88, IG 01-162, IG 01-124, IG 01-85	–	IG 01-87, IG 01–228	IG 01-141

Table2. Morphological characters (mean ±standard deviation) in different clusters of germplasm lines of *Panicum maximum*

Cluster no.	Plant height (cm)	Leaf length (cm)	Leaf width (cm)	Flag leaf length (cm)	Flag leaf width (cm)	Flag leaf sheath length (cm)	Peduncle length (cm)	Inflorescence length (cm)	Stem diameter (cm)
1	181.89 ±18.22	56.00± 13.39	1.95± 0.18	11.34± 2.22	1.17± 0.27	18.39± 2.05	42.07± 7.40	34.86± 5.13	0.44± 0.07
2	169.40 ±18.93	68.67± 10.97	2.27± 0.47	18.67± 4.66	1.65± 0.20	20.02± 3.11	30.26± 4.24	27.69± 2.88	0.50± 0.15
3	201.61 ±18.61	65.84± 10.87	1.95 ± 0.20	7.83± 1.97	0.70± 0.20	18.89± 1.43	50.45± 7.73	29.32± 2.63	0.42± 0.07
4	202.00 ±21.38	76.17± 5.39	1.63± 0.23	13.00± 2.29	1.20 ± 0.53	33.00± 3.04	44.50± 0.50	33.50± 2.60	0.42± 0.03
5	145.14 ±17.10	38.50± 11.24	1.64± 0.18	11.46± 3.34	0.97 ±0.31	17.57± 1.48	48.21± 11.71	27.21± 4.01	0.40± 0.07
6	206.33 ± 7.69	70.00± 5.00	2.20± 0.18	24.50± 4.27	1.68± 0.41	22.50± 3.91	47.33± 7.37	48.17± 2.25	0.43± 0.03
7	200.00 ±14.33	58.85± 13.11	1.62± 0.12	13.15± 4.84	1.00± 0.26	20.85± 2.55	64.35± 9.06	34.65± 2.39	0.48± 0.07

Table 3. Eigen vectors, eigen root values and variations for principal components in 63 accessions of Guinea grass.

Traits	EIGEN VECTORS								
1	0.095	0.295	0.368	0.482	0.515	0.242	-0.240	0.267	0.289
2	0.595	0.367	-0.186	-0.150	-0.190	0.375	0.403	0.337	-0.038
3	-0.151	-0.509	-0.397	0.385	0.279	0.028	0.427	0.379	-0.084
4	-0.352	0.187	-0.282	0.021	0.054	0.606	-0.302	-0.072	-0.543
5	-0.056	-0.064	-0.422	0.067	-0.092	0.374	-0.021	-0.397	0.710
6	-0.233	-0.105	-0.090	-0.260	-0.317	0.013	-0.425	0.707	0.278
7	-0.289	-0.269	0.563	-0.380	0.061	0.468	0.387	0.008	0.100
8	-0.500	0.450	0.107	0.407	-0.465	-0.105	0.368	0.055	0.063
9	-0.314	0.440	-0.280	-0.463	0.537	-0.249	0.202	0.069	0.138
Eigen roots	2.360	1.824	1.406	1.009	0.878	0.552	0.429	0.353	0.189
Variation (%)	26.22	20.27	15.62	11.22	9.75	6.14	4.77	3.92	2.10
Variation (cumulative)		46.49	62.11	73.33	83.08	89.22	93.99	97.91	100

Table 4. Inter-cluster distance among 7 clusters based on morphological characters.

Cluster no.	1	2	3	4	5	6	7
1	0.000						
2	2.953	0.000					
3	2.066	4.065	0.000				
4	4.282	4.869	4.296	0.000			
5	2.658	4.286	3.272	5.438	0.000		
6	4.071	4.326	5.292	4.880	6.123	0.000	
7	2.444	4.442	2.422	3.855	3.436	4.376	0.000

Discussion

The study of genetic relatedness helps in genetic upgradation programmes, as it throws light on selection strategies and evolutionary dynamics in a particular germplasm collection. Morphological traits have been used by several workers to assess the variability and identify donor for specific traits. In the present study, attempts were made to estimate diversity/similarity of various traits in 63 germplasm accessions collected principally from two geographical areas, Ethiopia (Africa) and India (South, North- east, Central plains and North-west regions).

An analysis of the principal components enables a synthetic description of the observed variability obtained by reducing the number of the original variables. In the present studies, the first three components accounted for 62.11% of total estimated variations. Eight principal components used in the cluster analysis accounted for 97.9 % of the observed variation. By examining the coefficients or eigen vectors of individual components, indications were obtained on their level of association with the original variables.

Characters such as leaf length (0.595), inflorescence length (-0.500) showed higher coefficients in the first component while the second component showed significant variation associated with the leaf width (-0.509), inflorescence length (0.450) and stem diameter (0.440). Flag leaf width (-0.422) and peduncle length (0.563) were found to characterize the third principal component.

In the present study, the material resolved into seven distinct clusters. As is clear from Table 1, the Indian collections were represented in all the seven clusters, whereas the Ethiopian collections were represented in five clusters only. The representation in different clusters, however, cannot be taken as an evidence of greater variability in Indian collections, which are represented by 50 accessions as compared to Ethiopian collections represented by 13 accessions only. Bulk of accessions (53.8%) were represented in cluster-1 and cluster-3, which are incidentally closest to each other. Ethiopian accessions are conspicuous by their absence in cluster-4 and cluster-6. Cluster–6 is represented by only three Indian collections and forms a conspicuous group in itself showing highest average values for four of the nine characters *viz.*, plant height, flag leaf length, flag leaf width and inflorescence length (Table 2). This cluster is having well above average distance from all other cluster centroids (Table 4). Similarly, cluster- 5 represented by four out of eleven (30.76%) Ethiopian collections were conspicuous in as much as it shows lowest average values for five of the nine characters including plant height (Table 2).

Unlike earlier studies where mean, range, coefficient of variation were taken as estimate of variability, the clustering augments the scope for selection of desirable types for genetic improvement programme as it provides an insight of genetic similarity among different germplasm lines.

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