Genetic Diversity for Yield and its Component Traits in Pearl Millet Germplasm

D Lakshmana[1], BD Biradar[2], D Madaiah[3] and RB Jolli[2]

[1] *AICRP on Pearl Millet, RARS, Bijapur-586101 UAS, Dharwad, Karnataka*

[2] *Regional Agricultural Research Station, Bijapur-586101, Karnataka*

[3] *Zonal Agricultural Research Station, Mudigere-577132, Karnataka*

One hundred and five genotypes of pearl millet representing different countries were studied for genetic divergence analysis utilizing Mahalanobis D^2 technique. The analysis of data revealed that significant difference was observed among the genotypes for all the traits. Based on the genetic distance (D^2 value), the 105 accessions were grouped into 22 clusters. Of the 22 clusters formed, cluster II was the largest with 63 genotypes followed by cluster III with 10 accessions. Among the twelve characters studied, the most important character contributing to the divergence was days to maturity and the traits like productive tillers/plant, grain yield/ear, peduncle length, grain yield/plant and 1000-seed weight were next in the order. Cluster I and XVII had maximum inter cluster distance suggesting wide diversity and by utilizing these accessions from these clusters desirable segregants may be evolved through hybridization. Maximum diversity was observed between IP-9416 vs. ICTP-8203, IP-5275 vs. IP-14644, IP-8276 vs. IP-18742.

Key Words: Genetic diversity, Cluster, Pearl millet, D^2 technique, Peduncle length

Introduction

Pearl millet (*Pennisetum glaucum* L.) is the fifth most important cereal food crop in India. Information on genetic diversity analysis helps to identify the genetically diverse genotypes for their use in breeding programmes. Choosing genetically diverse parents will enable the expansion of genetic base and development of superior types and greater success can be achieved through judicious choice of parents for hybridization based on genetic divergence. Crosses between divergent parent usually produce greater heterosis than those between closely related ones (Moll and Stuber, 1971). Of the several methods available Mahalanobis's generalized distance estimated by D^2 statistic (Rao, 1952) is a unique tool for discriminating population considering a set of parameters together rather than inferring from indices based on morphological similarities and polygenic relationship.

Mahalanobis's D^2 statistics has been followed by several workers on a wide range of crop species, including pearl millet, to measure the genetic distance among the breeding lines and to identify characters responsible for such divergence. The present investigation aims to determine the genetic diversity among 105 accessions of pearl millet of indigenous and exotic origin using cluster analysis based on morphological traits.

Materials and Methods

The material for the present investigation comprised 105 accessions of pearl millet including 26 lines from India and 79 from African countries, *viz.*, Togo, Sudan, Tanzania, Mali, Camerron, Zimbabwe, Namibia, Nigeria, Burkino Faso, Ghana, and nine from ICRISAT, Hyderabad. Thus, the material represented a wide range of geographic diversity. The experiment was carried out in a Randomized Block Design with three replications at Regional Agricultural Research Station, Bijapur (University of Agricultural Sciences, Dharwad) during *Kharif,* 2004 and 2005. Each accession was grown in two lines of 4 m length. The spacing adopted between rows and between plants with in a row was 50 cm and 15 cm, respectively. The data on days to 50% flowering, days to maturity, plant height, ear length, ear girth, flag leaf area, peduncle length, ear weight, grain yield/ear, grain yield/plant and 1000-seed weight were recorded on five randomenly selected labeled plants for all the entries in each replication All the observations except days to 50% flowering were taken at maturity. The mean data of two seasons was subjected to statistical analysis using Mahalanobis D^2 statistic to assess genetic divergence. The accessions were grouped on the basis of minimum generalized distances using the Tocher's method (Rao, 1952).

Results and Discussion

Analysis of variance revealed significant difference among the accessions for all the characters studied, indicating the existence of wide genetic divergence among them. Based on D^2 values, 105 genotypes were grouped in 22 clusters, indicating the presence of large amount of

diversity among the genotypes (Table 1). Maximum number of genotypes (63) were in cluster II, ten were grouped in cluster III, four each in cluster I, XV and XVII (Table 1) The dendrogram of 105 pearl millet genotypes depicting the spatial position of each cluster in relation to others is presented in Fig.1.

The intra- and inter-cluster D^2 values among the 22 clusters are presented in Table 2. Cluster XV had the maximum intracluster distance of 24.6 followed by cluster II (23.6) and cluster III (22.0). The inter cluster distance ranged between 12.9 minimum (X and XI) and 249.0 maximum (I and XVII). The inter cluster proximity

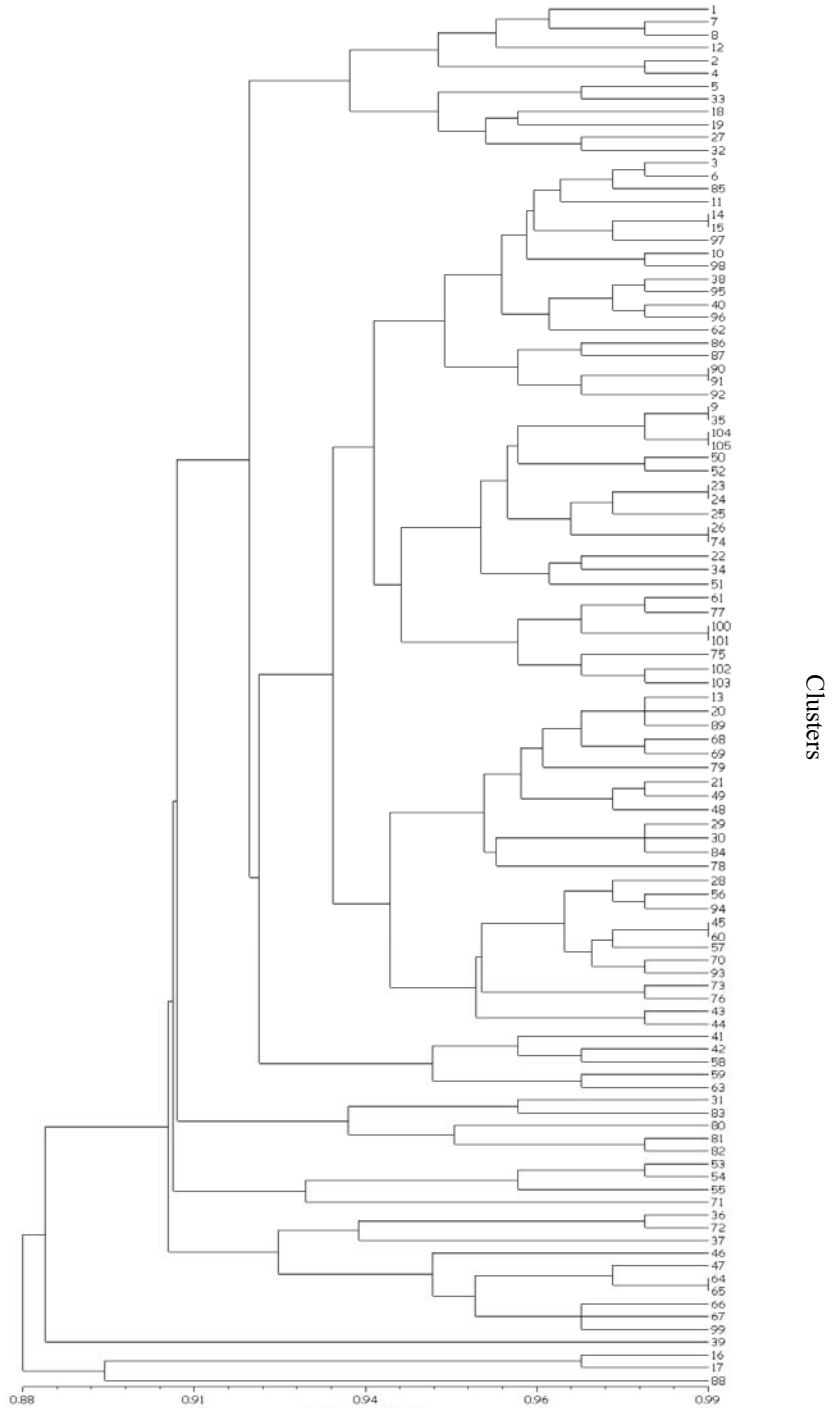

Fig. 5: Dendrogram of 105 pearl millet germplasm lines

Table 1. Distribution of 105 pearl millet genotypes into different clusters

Cluster number	Total number of genotypes in each cluster	Genotypes included in the clusters	Origin
I	4	IP-9140, IP-9286, IP-15857, IP-15899	India=1 Togo=1 Tanzania=2
II	63	IP-11211, ICTP-8203, WC-075, IP-8540, ICMV-221, IP-15355, IP-15256, IP-4759, IP-15257, IP-14942, IP-10394, IP-3150, IP-4169, IP-15220, IP-15273 IP-12779, IP-7838, IP-17978, IP-12682, IP-8276, IP-8069, IP-12768 IP-17566, IP-17753, IP-9301, IP-17493, IP-17690 IP-10761, IP-10914, IP-10839, IP-10945 IP-15817, IP-15710, IP-15681, IP-15829 IP-10085, IP-6451, IP-6417, IP-10186, IP-6460, IP-6545 IP-12901, IP-14497, IP-6125 IP-14028, IP-16911, IP-16449, IP-8818, IP-16402, IP-14026 IP-19246, IP-17144, IP-18657, IP-18742, IP-19388 IP-5275, IP-19067, IP-13137 IP-11503, IP-13840, IP-10339, IP-13875 IP-8416	India=15 ICRISAT=7 Togo=5 Sudan=4 Tanzania=4 Mali=6 Camerron=3 Zimbabwe=6 Namibia=5 Nigeria=3 Burkino Faso=4 Ghana=1
III	10	IP-14038 IP-16196, IP-4695, IP-4779 IP-17979 IP-14644, IP-14778 IP-19321 IP-7488 IP-8429	Zimbabwe=1 India=3 ICRISAT-1 Camerron=2 Namibia=1 Tanzania=1 Nigeria=1
IV	1	IP-11680	Sudan=1
V	1	IP-10811	Sudan=1
VI	1	IP-15364	India=1
VII	1	IP-19243	Namibia=1
VIII	1	IP-19361	Namibia=1
IX	1	IP-18800	Namibia=1
X	1	IP-12474	India=1
XI	4	IP-11577, IP-13833 IP-18625 IP-16690	Burkino Faso=2 Namibia=1 Zimbabwe=1
XII	1	IP-16197	India=1
XIII	1	IP-13154	Nigeria=1
XIV	1	IP-18389	Namibia=1
XV	4	IP,13645, IP-4331 IP-17144, IP-16638	India=2 Zimbabwe=2
XVI	1	IP-10826	Sudan=1
XVII	4	IP-17028, IP-10488, IP-18621 IP-7440	Zimbabwe=2 Namibia=1 Tanzania=1
XVIII	1	IP-10085	Mali=1
XIX	1	IP-6510	Mali=1
XX	1	IP-8229	ICRISAT=1
XXI	1	IP-3799	India=1
XXII	1	IP-9149	India=1

seems to be minimum between cluster X and XI as indicated by lowest inter cluster distance of 12.9. Hence, the genotypes included in cluster I and XVII may be selected for more effective crossing programme and should result in wide spectrum of variability to operate selection in segregating population. Presence of diversity among pearl millet genotypes of the present study is in accordance with earlier reports (Yadav, 1994; Hepziba *et al*., 1995).

Based on D^2 values, per cent contribution of different characters towards divergence was obtained. Among the twelve quantitative characters studied the most important

Table 2. Average intra-cluster inter-cluster distances for 22 clusters in 105 pearl millet genotypes

Clusters	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII
I	6.0	231.8	253.0	218.6	239.9	227.8	232.4	221.9	218.6	218.8	229.2	225.4	221.8	225.0	242.1	236.9	249.0	242.7	231.6	198.3	220.0	141.8
II		23.6	33.5	31.6	31.9	34.4	29.7	30.7	28.3	33.0	28.5	30.5	39.2	31.7	36.7	29.4	33.3	42.4	34.6	57.8	73.5	218.0
II			22.0	51.4	35.0	48.4	32.9	41.3	47.9	51.8	44.1	41.6	50.1	49.7	35.0	35.2	32.5	41.2	42.1	74.0	89.9	235.3
IV				0.00	43.8	30.0	46.6	40.3	14.0	14.7	14.8	41.1	47.4	14.6	52.0	35.4	39.7	57.1	45.0	59.1	67.8	210.2
V					0.00	23.1	42.3	48.6	37.3	36.3	33.4	45.5	57.5	40.4	48.5	44.3	31.6	18.3	22.0	61.2	71.1	226.9
VI						0.00	51.8	51.3	24.0	20.4	21.9	48.3	59.6	28.9	55.9	47.7	36.8	34.7	26.9	56.9	62.8	219.3
VII							0.00	20.3	43.8	49.2	45.3	23.4	27.9	46.3	32.0	29.6	44.0	49.2	43.8	58.5	80.2	215.5
VIII								0.00	38.0	45.9	44.0	14.4	17.6	45.1	28.9	35.7	51.0	54.9	43.6	48.5	78.1	206.8
IX									0.00	15.0	18.0	38.6	46.4	16.8	48.9	35.3	38.1	49.6	37.7	55.0	66.3	211.8
X										0.00	12.9	46.5	55.2	16.9	57.3	40.0	37.7	49.8	40.3	58.6	64.3	213.4
XI											0.00	43.7	52.8	14.8	51.5	34.0	29.2	47.7	39.3	63.4	69.2	220.7
XII												0.00	13.8	45.3	26.7	40.1	51.5	50.4	37.1	42.8	71.1	205.7
XIII													0.00	51.7	31.9	43.2	60.3	63.2	50.0	48.1	76.2	200.4
XIV														0.00	55.2	30.2	33.9	56.1	46.9	66.3	66.1	218.0
XV															24.6	43.3	50.5	51.9	43.3	60.9	87.3	219.9
XVI																0.00	30.5	58.4	53.6	75.1	82.6	224.8
XVII																	21.9	45.3	45.8	79.5	84.0	237.2
XVIII																		0.00	19.6	59.3	78.4	227.4
XIX																			0.00	43.8	66.9	215.1
XX																				0.00	63.2	181.9
XXI																					0.00	200.8
XXII																						0.00

Underlined figures indicates intra-cluster distance

Percent contribution of each character towards genetic divergence in pearl millet

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	Productive tillers/ ear	Plant length (cm)	Ear girth (cm)	Flag leaf area (cm^2)	Peduncle length (cm)	Ear weight (g)	Grain yield per ear (g)	Grain yield per plant (g)	1000-grain weight (g)
% Contribution	0.13	32.58	0.09	36.23	0.42	0.35	0.00	0.48	0.04	0.31	20.26	9.12

Table 3. Cluster means values for twelve traits of 22 clusters in 105 pearl millet genotypes

Characters	Percent contribution of each character towards genetic divergence in pearl millet											
	Days to 50 % flowering	Days to maturity	Plant height (cm)	Productive tillers/ ear	Plant length (cm)	Ear girth (cm)	Flag leaf area (cm^2)	Peduncle length (cm)	Ear weight (g)	Grain yield per ear (g)	Grain yield per plant (g)	1000-grain weight (g)
I	51.33	86.83	182.24	2.58	20.98	7.51	85.36	21.10	35.02	22.18	61.72	11.28
II	50.22	86.66	172.97	2.13	23.52	7.68	81.21	21.97	49.80	26.72	62.16	9.63
III	51.17	87.80	176.89	2.07	25.18	7.63	79.03	21.54	48.26	26.00	60.90	8.73
IV	51.67	90.33	168.00	1.93	19.10	7.50	93.00	19.83	47.87	20.20	32.67	7.70
V	50.33	85.00	185.63	2.63	24.23	6.00	87.60	22.43	53.40	30.70	73.67	10.20
VI	51.33	87.67	190.67	2.07	29.80	5.73	99.40	23.37	43.33	20.23	47.97	8.83
VII	50.00	83.33	171.57	2.47	23.23	8.23	92.13	23.27	48.67	23.30	69.10	10.77
VIII	50.00	85.00	170.10	1.97	21.63	8.10	81.03	21.33	42.33	21.73	50.13	9.00
IX	48.67	86.67	160.47	2.00	28.73	8.37	71.50	20.70	43.00	19.83	37.50	7.17
X	46.67	84.67	171.83	2.13	23.83	6.93	73.33	22.37	44.17	21.57	70.30	12.63
XI	48.25	86.00	174.00	2.60	25.20	6.10	78.00	22.20	46.50	24.80	65.90	10.80
XII	51.33	89.00	171.23	2.23	29.17	8.23	67.93	19.03	53.07	21.43	37.53	6.80
XIII	45.00	83.67	190.83	1.57	19.27	6.97	88.17	24.00	60.97	34.67	86.00	13.70
XIV	47.67	86.67	171.00	2.67	23.37	8.07	75.00	20.17	42.03	21.50	50.83	7.70
XV	48.83	84.75	171.47	2.00	24.13	7.00	84.15	19.43	48.69	22.05	45.96	8.02
XVI	46.33	85.00	170.60	2.47	20.87	8.83	69.50	25.33	51.23	25.33	57.93	10.13
XVII	50.33	86.83	176.21	2.08	26.79	9.20	83.13	23.65	49.73	26.73	62.31	8.88
XVIII	52.67	89.00	188.67	2.90	24.83	6.73	99.83	26.63	53.57	27.77	67.00	11.20
XIX	54.00	92.00	203.03	1.93	20.67	9.17	71.13	27.93	42.67	20.20	43.20	6.70
XX	50.67	86.33	189.83	2.30	20.60	8.63	79.50	21.47	51.77	28.67	60.87	11.07
XXI	49.00	85.67	187.13	2.10	22.20	8.63	54.97	26.60	38.47	27.60	70.67	9.03
XXII	47.00	87.33	189.50	2.20	15.67	9.03	91.27	20.10	40.50	27.30	63.37	10.27

character contributing to the divergence was days to maturity. The traits like productive tillers/ plant, grain yield per ear, peduncle length, grain yield per plant, 1000-seed weight were next in the order. These characters can be given greater importance in selection of potential parents for hybridization. These observations are in line with the observations of earlier workers (Hepziba *et al*., 1995; Quendeba *et al*., 1995).

The existence of diversity among the genotypes was also assessed by the considerable amount of variation in cluster means for different characters (Table 3). Genotypes in cluster VII, XIII, X, XV and VIII were the early maturing. The genotypes in clusters XIX, XIII and VI were tallest, and cluster IX had the dwarf genotype. The cluster mean for ear length ranged from 15.67 cm to 29.80 cm, which were attained by group XXII and VI, respectively. The maximum ear girth was noticed in cluster XVII (9.20) while minimum was observed in cluster V (6.0). Less number of productive tillers per plant was recorded by the individuals in the cluster XIII (1.57), while more number was seen in cluster XVIII (2.90). Regarding peduncle length, cluster XIX had the highest mean value (27.93 cm), while cluster means for flag leaf area was in the range of 54.97 (cluster XXI) to 99.40 cm^2 (cluster VI). The mean values for ear head weight per ear was in the range of 35.02 (cluster I) to 60.97 g (cluster XIII). The maximum grain yield per ear head was produced by genotypes in cluster XIII (34.67 g). The minimum grain yield per ear head was recorded by genotypes in cluster IX (19.83 g). The higher mean grain yield per plant was recorded by the genotypes in cluster XIII (86.00 g), while lower grain yield was noticed in cluster IV (32.67 g). With respect to 1000-grain weight, cluster XIII had highest mean value (13.70 g) followed by cluster X (12.63 g) and cluster I (11.28 g). Cluster XIX had very low mean values for grain weight (6.70 g).

Maximum diversity was observed between IP-9416 vs. ICTP-8203 followed by IP-5275 vs. IP-14644 and IP-8276 vs. IP-18742. These divergent pairs will make 'B' and 'R' line combinations at least on any one of the CMS sources. If such hybrids are good, the corresponding cytoplasmic sources can be used for developing male sterile version and utilized in hybridization programme for developing hybrids or can be involved in crossing programme (B x R) for creating variability to isolate superior 'B' and 'R' lines on one or two cytoplasm.

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References

Hepziba SJ, M Teradimani, R Saraswathi and S Palanisamy (1995) Genetic divergence in pearl millet [*Pennisetum glaucum* (L.) R.Br.]. *Crop Res.* **9:** 96-104.

Hussain SH (1973) Multivariate analysis and group distribution in world collection of *Eleusine coracana* Gaertn. NCSI, Publication, 81 p.

Moll and CW Stuber (1971) Comparison of response to alternative selection procedures initiated with two population of maize (*Zea mays* L.). *Crop Sci.* **11:** 706-711.

Murthy BR and MI Quadri (1966) Analysis of divergence in some self compatible forms of *Brassica campestris* (L.) Var. Brown sarson. *Indian J. Genet.* **20:** 45-48.

Quendeba B, G Ejeta, WW Hanna and AK Kumar (1995) Diversity among African pearl millet landrace populations. *Crop Sci.* **35:** 919-924.

Rao CR (1952) Advanced Statistical Methods in Biometric Research. John Wiley and Sons, Inc. New York. 390p.

Yadav OP (1994) Genetic divergence in pearl millet accessions of Indian and exotic origin. *Indian J. Genet.* **54:** 89-93.