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Genetic diversity for morpho-physiological traits in inbreds, maintainers, restorers and male sterile lines of pearl millet

SANJAY PAWAR, G.D. DHORAN AND P.K. JAGTAP

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SUMMARY

Thirty five genotypes studied in the present investigation were grouped into 9 clusters. The intra-cluster distance was maximum within cluster III (D=15.6), while it was minimum within cluster IV (D=9.6). The inter-cluster distance was maximum between cluster II and IV (D=67.8), while it was minimum (D=14.65) between cluster V and VII (both solitary). Cluster VIII had characterized by genotype having highest grain yield, highest number of productive tillers, low CSI and low stomata density (both abaxial/adaxial) and was the best cluster. The trichome density showed the highest percentage of contribution towards divergence (61.08 %) followed by earhead length (19.33 %).

Key words : Pearl-millet, Genetic diversity, Morpho-physiological traits

Pearl millet [*Pennisetum glaucum* (L.) R.Br.] is an important food crop of semi-arid tropics and stands fifth among the cereals. In India, the total area under this crop is 10 million hectares with the production of 8.55 million tonnes and productivity 707 kg per hectare. In Maharashtra, it is cultivated in 15.29 lakh hectares with production of 11.26 lakh tonnes and productivity of 656 kg per hectare (Anonymous, 2008). Crop improvement depends on the magnitude of genetic variability and the extent to which the desirable characters are heritable. Naturally, number of workers has studied the diversity for various agronomic, morphological and molecular traits in bajra (Upadhyay and Murthy, 1970; Reddy and Sharma, 1984). However, very few attempts have been made to study genetic diversity jointly at physiological and morphological level. Important physiological attributes such as chlorophyll stability index (CSI), stomata density needs to be involved to get reliable improvement in the yield both by selection and by exploitation of hybrid vigour because in India bajra is mostly grown in rainfed condition. So, it frequently suffers from intermittent droughts. Therefore, it becomes necessary to breed for rainfed bajra hybrids/composites having desirable physiological background which is represented by CSI and stomata density. Therefore, in addition to the A, B, R lines an inbreds were also subjected to know the genetic diversity for morpho-physiological components of yield.

Correspondence to:
P.K. JAGTAP, Oilseeds Research Station, LATUR (M.S.) INDIA
Authors' affiliations:
SANJAY PAWAR AND G.D. DHORAN, Mahatma Phule Krishi Vidyapeeth, Rahuri, AHMEDNAGAR (M.S.) INDIA

MATERIALS AND METHODS

Total 35 genotypes, including male sterile lines, maintainers, restorers and inbreds of Pearl millet received from AICRP on Bajra, Dhule were used for the present study. The experiment was laid out in Randomized Block Design with three replications. Two rows of 4.5 meter length were grown for each genotype in each replication, at the spacing of 45 x 15 cm. The recommended package of practices was followed. Fertilizer dose @ 60 kg N, 30 kg P_2O_5 and 30 kg K_2O per hectare were applied, of which half dose of N and full dose of P and K was applied at the time of sowing. Remaining half dose of nitrogen was top dressed one month after sowing. The mean values of ten randomly selected observational plants for ten different traits were used for statistical analysis. The generalized distance between any two populations was evaluated as per Mahalanobis (1936) and Tocher's method as described by Rao (1952) was followed for cluster formation.

RESULTS AND DISCUSSION

In the present investigation, 35 parental lines were grouped into 9 clusters. Male sterile DHBL-709 and inbred DHBL-735 were genetically farthest (D=72.62) and were naturally placed in different clusters. On the contrary, male 74 sterile line DHBL-711 and DHBL-712 had least genetic distance (D=4.45) between them and were genetically closest to each other and, therefore, found place in the same cluster. In spite of much diverse material and large number of clusters the genetic distance between individual genotypes studied by Mukherji *et al*. (1981) varied from 1.62 to 20.69 only.

Nine different clusters formed in the present study indicated that the genotypes studied possessed ample variability. Cluster I accommodated the largest number (15) of genotypes followed by cluster III with 10 genotypes, cluster II with 3 genotypes and cluster IV with 2 genotypes (Table 1). Cluster V, VI, VII, VIII and IX were mono-genotypic. Similar pattern of cluster-wise number of genotypes was observed in the previous studies of Mukherji *et al*. (1981) who grouped 51 inbreds into 14 clusters as they were collected from widely distributed places throughout India. Salunke (2003) grouped 60 genotypes into only 7 clusters among which 54 genotypes concentrated in a single cluster and rest of the six genotypes formed six solitary clusters indicating lack of sufficient diversity in the material studied. Maximum intra-cluster distance was observed for the genotypes in cluster III (D=15.212). Genotypes in cluster II exhibited minimum intra-cluster distance (D=10.930). In spite of really diverse genotypes the intra-cluster distance of Mukherji *et al*. (1981) showed relatively narrow range *i.e*. from 4.95 to 10.95. Cluster II and IV exhibited maximum inter-cluster distance (D=67.871) followed by cluster II and VII (D=66.410), cluster II and V (D=65.665), cluster I and II (D=64.92), cluster VII and IX (D=48.396) and cluster VI and VII (D=47.329) indicating that genetic makeup of parental line included in these clusters may be entirely different from one another and substantial hybrid vigour can be expected (Table 2).

Based on character wise cluster means (Table 4.5) it was observed that solitary cluster VIII was characterized by the highest seed yield/plant (68.63 g/ plant), higher number (5) of productive tillers/plant, low CSI and low stomata density (adaxial/abaxial) (Table 3). Solitary cluster V was the second highest in yield/plant

Table 1 : Grouping of 35 parental lines of pearl millet into different clusters by Tochers method

Clusters	Parental lines				Total genotypes
	A-lines	B-lines	R-lines	Inbreds	
I	DHBL-711	DHBL-726	DHBL-701	DHBL-736	15
	DHBL-712		DHBL-702	DHBL-737	
	DHBL-714		DHBL-704	DHBL-739	
	DHBL-715		DHBL-705	DHBL-740	
	DHBL-716		DHBL-706		
II	-	DHBL-723	-	DHBL-730	3
				DHBL-735	
III	DHBL-710	DHBL-720	DHBL-703	DHBL-732	10
	DHBL-719	DHBL-724		DHBL-734	
		DHBL-727			
		DHBL-728			
		DHBL-729			
IV	DHBL-709	-	-	-	2
	DHBL-717				
V	-	DHBL-722	-	-	1
VI	DHBL-718	-	-	-	1
VII	-	DHBL-725			1
VIII	-	-	-	DHBL-731	1
IX	DHBL-708	-	-	-	1

Table 2 : Inter (above diagonal) and intra-cluster (diagonal) D values for ten clusters

	Cluster I	Cluster II	Cluster III	Cluster IV	Cluster V	Cluster VI	Cluster VII	Cluster VIII	Cluster IX
Cluster I	11.412	64.932	27.579	18.911	19.985	44.194	23.521	35.066	37.943
Cluster II		10.930	42.290	67.871	65.665	23.239	66.410	39.602	37.688
Cluster III			15.212	33.747	28.569	22.801	30.399	21.119	25.562
Cluster IV				9.734	30.525	47.037	35.349	35.821	34.511
Cluster V					0.0	45.622	14.651	37.769	45.268
Cluster VI						0.0	47.329	21.225	21.582
Cluster VII							0.0	36.672	48.396
Cluster VIII								0.0	24.830
Cluster IX									0.0

Table 3 : Cluster means for 10 characters in pearl millet

Cluster No.	CSI (nm)	Trichome density (No./cm^2)	Stomata density (upper epidermis) (No./mm^2)	Stomata density (lower epidermis) (No./mm^2)	Harvest index (%)	Leaf area (cm^2/plant)	Earhead length (cm)	No. of productive tillers/ plant	No. of grains/ cm^2 of earhead	Grain yield (g/plant)
Cluster I	0.2521	0.0	82.604	92.747	27.076	1513.844	15.485	1.622	22.389	42.889
Cluster II	0.2314	22.344	79.367	89.144	27.933	1547.00	17.050	1.711	22.222	46.556
Cluster III	0.2414	8.207	81.913	94.613	27.723	1558.60	19.524	1.553	23.870	44.663
Cluster IV	0.265	1 0.0	73.433	88.817	27.527	898.167	10.083	4.333	21.783	37.40
Cluster V	0.26	10 0.0	82.567	93.033	28.97	1564.0	28.45	2.00	18.867	64.433
Cluster VI	0.226	14.767	87.400	107.167	27.497	1324.667	18.900	2.800	24.767	48.66
Cluster VII	0.28	7 0.0	80.467	95.533	27.100	2236.0	26.71	2.163	29.100	53.43
Cluster VIII	0.2343	10.133	77.500	89.233	26.420	1582.333	18.217	5.00	25.367	68.633
Cluster IX	0.2887	11.767	73.567	86.400	26.127	758.333	12.05	4.0	21.233	23.00

(64.43 g/plant) and was characterized by long earheads, high harvest index, bold grains and lower adaxial/abaxial stomata density. Cluster I, II, III and VI showed medium seed yield/plant as most of the yield components were of intermediate magnitude. Cluster IX and IV were least yielders were mainly due to short earheads, in spite of having more (4.0 and 4.3, respectively) number of productive tillers/plant. Cluster mean for trichome density was maximum in cluster II. Earhead length and harvest index were maximum whereas, number of grains/cm^2 of earhead were minimum in cluster V. Cluster IX was characterized by minimum leaf area/plant and minimum adaxial/abaxial stomata density. Past workers have not elucidated characteristics of each cluster.

Maximum relative contribution towards divergence showed by trichome density (61.08 %) followed by earhead length (19.33 %). Number of productive tillers/ plant (5.04 %), number of grains/cm^2 of earhead (3.53 %), leaf area (4.20 %) contributed moderately towards genetic divergence, while grain yield (1.85 %), harvest index (1.10 %), stomata density (1.01 % for both adaxial and abaxial) contributed least towards genetic divergence (Table 4). Correlation of GCV and PCV of different characters with per cent contribution of these characters to genetic diversity was almost unity indicating that when GCV and PCV of characters are high, its per cent contribution to diversity should be necessarily high with some exceptions. Grain yield appeared to be an example of such exception in which GCV and PCV values were quite higher (16.54 and 17.55 %, respectively) than the harvest index (3.62 % PCV, 2.84 % GCV) and stomata density (both adaxial and abaxial *i.e.* PCV 6.93 and 7.38; GCV 6.61and 7.09, respectively) but the per cent of contribution of these traits to the genetic diversity was almost same.(1.01 to 1.85). Considering the mean values, the potential clusters that can provide the parents for hybridization program for improvement in the concerned characters are detailed below (Table 5). Thus combined study of morpho-physiological traits in the form of diversity provided appreciable opportunity to select the parents to

Table 4 : Per cent contribution of various characters to divergence in pearl-millet

Sr. No.	Characters	Per cent contribution
1.	Chlorophyll stability index (nm)	1.85
2.	Trichome density (No./cm^2)	61.08
3.	Adaxial stomata density (No./mm^2)	1.01
4.	Abaxial stomata density (No./mm^2)	1.01
5.	Harvest index (%)	1.10
6.	Leaf area (cm^2/plant)	4.20
7.	Earhead length (cm)	19.33
8.	Number of productive tillers/ plant	5.04
9.	Number of grains/cm^2 of earhead	3.53
10.	Grain yield (g)/plant	1.85

Table 5 : Character wise source cluster in pearl millet

Sr. No.	Characters	Source clusters (in descending order of mean values)
1.	CSI (nm)	VI, III, VII
2.	Trichome density (No./cm^2)	II, VI, IX
3.	Adaxial stomata density (No./mm^2)	IV, IX, VIII
4.	Abaxial stomata density (No./mm^2)	IX, IV, II
5.	Harvest index (%)	V, II, III
6.	Leaf area (cm^2/plant)	IX, IV, VI
7.	Earhead length (cm)	V, VII, III
8.	Number of productive tillers/plant	VIII, IV, IX
9.	Number of grains/cm^2 of earhead	V, IX, IV
10.	Grain yield (g)/plant	VIII, V, VII

develop superior hybrids/composites having sound physiological background.

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