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PATTERN OF GENETIC DIVERSITY AND VARIABILITY IN PROSO MILLET (*PANICUM MILIACEUM* L.)

S. Ganga Prasad, G.S. Siddaraju, A. Seetharam and B.T.S. Gowda

AICRP on Small Millets
UAS, GKVK, Bangalore - 560 065

One hundred proso millet (Panicum miliaceum *L.*) *germplasm which included 50 from erstwhile USSR and 50 from India, were evaluated for variability and magnitude of genetic divergence using Mahalanobis's* D^2 *analysis. Genetic variability was substantial for nodal, basal and main tiller yield in both Indian and USSR accessions, while for grain yield per plant, it was high in USSR accessions and moderate in Indian germplasm. In contrast, it was high for flag leaf area in Indian and moderate in USSR accessions. For number of basal tillers, it was moderate in both groups of accessions. For rest of the characters variability was low in both the groups. The* D^2 *analysis grouped all accessions into 8 clusters. The USSR accessions were distributed in 4 clusters and Indian in 6 clusters. The characters — days to 50 percent flowering, days to maturity, peduncle length, nodal tiller yield, basal tiller yield, main tiller yield and flag leaf area — which showed high genetic variability also contributed for genetic divergence. Geographical diversity was found associated with genetic diversity.*

Proso or common millet (*Panicum miliaceum* L.) is grown over 0.2 million hectares in India and is important because of its assured harvest in areas of low rainfall. The erstwhile USSR with an area of over 3 million hectares is the largest producer of proso millet in the world. Considering the antiquity of cultivation, it is presumed that Proso millet was first domesticated in Eurasia in the area falling in Central Asia, Afghanistan and India. Later, it moved westwards to Europe and eastwards to East Asia, during which

period gradual genetical differentiation took place (Sakamoto, 1987). Attempt has been made to compare the variability and magnitude of genetic diversity between Indian and erstwhile USSR accessions in the present studies.

MATERIAL AND METHODS

The material for the present investigations comprised 50 accessions from erstwhile USSR and 50 representative Indian accessions of proso millet. The 100 accessions were planted in 10 x 10 simple lattice design with two replications during summer 1988. Each accession was sown in a single row of 3 m length with a spacing of 22.5 cm between rows and 10 cm between plants within a row. Recommended agronomic practices were followed in raising the crop. Observations on the 15 metric traits were recorded on 10 random plants in each accession. Estimation of phenotypic and genotypic coefficient of variation was made as per the method suggested by Burton and Devane (1953). Multivariate analysis (Mahalanobis, 1936; Rao, 1952) was done on mean values for computing the genetic divergence between accessions and the D^2 values thus obtained were used for clustering the accessions using Tocher's method. The Wilks' lambda test criterion (Wilks, 1932) was used for testing the significance of genotypes.

RESULTS AND DISCUSSION

The analysis of variance revealed highly significant differences among the accessions for all the 15 characters in Indian and USSR accessions except main tiller yield in USSR accessions. Range, mean and coefficient of variability are presented in Table 1. The Indian accessions were superior to USSR accessions for all the fifteen characters except peduncle length and protein content. The higher GCV of 153.30 per cent was recorded for nodal tiller yield in USSR accessions as against 67.59 per cent in Indian accessions. Basal and main tiller yield recorded high GCV of around 50 per cent in both the groups. For yield per plant, the USSR accessions recorded high variability of 60 per cent compared to 36.49 per cent of Indian. The variability for basal tiller number was moderate in both the groups. The GCV was moderate for nodal tillers and peduncle length in Indian, while it was low in USSR accessions. For the remaining traits, the variability was low in both the groups.

Table 1 : Genetic parameters of 15 metric characters of USSR and Indian germplasm

Character		Range		Mean	PCV	GCV
		Min.	Max.			
Plant height (cm)	U	38.25	98.00	62.98	20.64	20.38
	I	53.71	133.60	94.41	16.47	15.60
Peduncle length (cm)	U	13.89	35.52	23.76	22.22	20.66
	I	7.24	24.99	14.26	36.26	33.74
Inflorescence length (cm)	U	8.50	23.68	15.20	25.29	22.57
	I	13.64	33.18	24.50	18.12	16.63
Number of primary inflorescence branches	U	3.62	8.87	6.64	18.96	16.39
	I	4.25	11.38	7.82	24.73	18.67
Number of nodal tillers	U	1.12	3.50	2.07	33.45	23.97
	I	0.43	5.50	2.75	49.75	37.99
Number of basal tillers	U	0.81	5.75	2.92	36.96	33.88
	I	1.08	6.69	4.05	39.69	35.84
Days to 50% flowering	U	23.00	31.50	26.26	7.86	7.49
	I	26.00	44.50	34.70	12.04	11.63
Days to maturity	U	56.00	70.55	63.05	6.46	5.48
	I	60.50	80.50	72.65	12.04	7.30
Flag leaf area (cm^2)	U	9.74	84.88	27.05	32.50	30.52
	I	15.13	92.89	39.68	54.02	53.32
Test weight (g)	U	3.60	7.60	5.06	18.77	15.31
	I	3.55	7.10	5.32	21.72	18.25
Protein content (%)	U	7.40	13.44	10.06	18.06	17.53
	I	6.90	13.10	9.86	16.76	16.59
Nodal tiller yield (g)	U	0.03	11.38	1.03	156.62	153.30
	I	0.25	4.80	1.60	73.89	67.59
Basal tiller yield (g)	U	0.18	3.33	1.69	58.43	53.55
	I	0.31	10.35	4.27	54.97	50.59
Main tiller yield (g)	U	0.30	4.43	1.29	58.75	53.67
	I	0.78	7.73	2.37	69.37	67.21
Yield/plant (g)	U	0.50	15.15	3.93	62.86	60.00
	I	2.21	17.50	8.23	39.07	36.49

U = USSR Accessions, I = Indian Accessions.

Based on D^2 values, the accessions were grouped into 8 clusters (Table 2). The 50 USSR accessions got distributed in 4 clusters and 50 Indian accessions in 6 clusters. Cluster I has been formed with 55 accessions of which 47 are of USSR origin and 8 are of Indian origin. The cluster II composed 29 accessions — 1 USSR and 28

Table 2 : Formation of clusters and accessions included in each cluster

Cluster number	No. of Strains	Accession number of entries
I	55	EC212510, EC212532, EC212512, EC212542, EC212521, EC212520, BTC-2, EC212525, EC212494, GPms 380, EC212508, EC212482, GPms 554, EC212502, EC212500, EC212483, EC212524, EC212515, EC212503, EC212492, EC212522, EC212531, EC212519, EC212530, EC212539, EC212504, EC212499, EC212498, EC212536, EC212501, EC212520, EC212527, EC212486, EC212514, EC212487, EC212495, EC212535, EC212496, GPms 589, EC212517, EC212511, EC212535, EC212540, BTS-1, EC212484, EC212518, EC212491, EC212506, EC212529, GPms 507, EC212485, GPms 510, GPms 509, GPms 383, GPms 553
II	29	GPms 446, GPms 454, GPms 387, GPms 393, GPms 365, GPms 495, GPms 398, GPms 391, GPms 399, GPms 466, GPms 390, GPms 450, GPms 430, GPms 482, GPms 438, GPms 441, GPms 396, GPms 368, GPms 397, GPms 432, GPms 514, GPms 392, GPms 575, GPms 506, GPms 570, GPms 382, EC212489, GPms 367, GPms 510
III	8	GPms 373, GPms 378, GPms 512, GPms 374, GPms 377, GPms 376, GPms 458, GPms 370
IV	3	GPms 384, GPms 388, GPms 389
V	2	GPms 372, GPms 375
VI	1	GPms 385
VII	1	BTS-3
VIII	1	EC212545

Indian. Cluster III, IV and V have 8, 3 and 2 Indian accessions, respectively. The remaining 3 clusters were solitary ones with cluster VI having one Indian accession and Cluster VII and VIII having one USSR accession each. Around 40 per cent of the D^2 were non-significant suggesting that an equal amount of the germplasm could be genetically similar. However, the remaining 60 per cent showed greater distance and greater diversity. The USSR accession EC212545 was most distant from the rest. The cluster wise mean value for the fifteen characters are presented in table 3.

The Z values obtained for character means for two nearest clusters (I and VII) and two distant clusters ((III and VIII) are presented in a profile graph (Fig. 1). It could be seen from the graph that the cluster I and VII have a similar trend for most of the characters while the distant clusters III and VIII indicated an opposite trend in majority of the characters such as peduncle length,

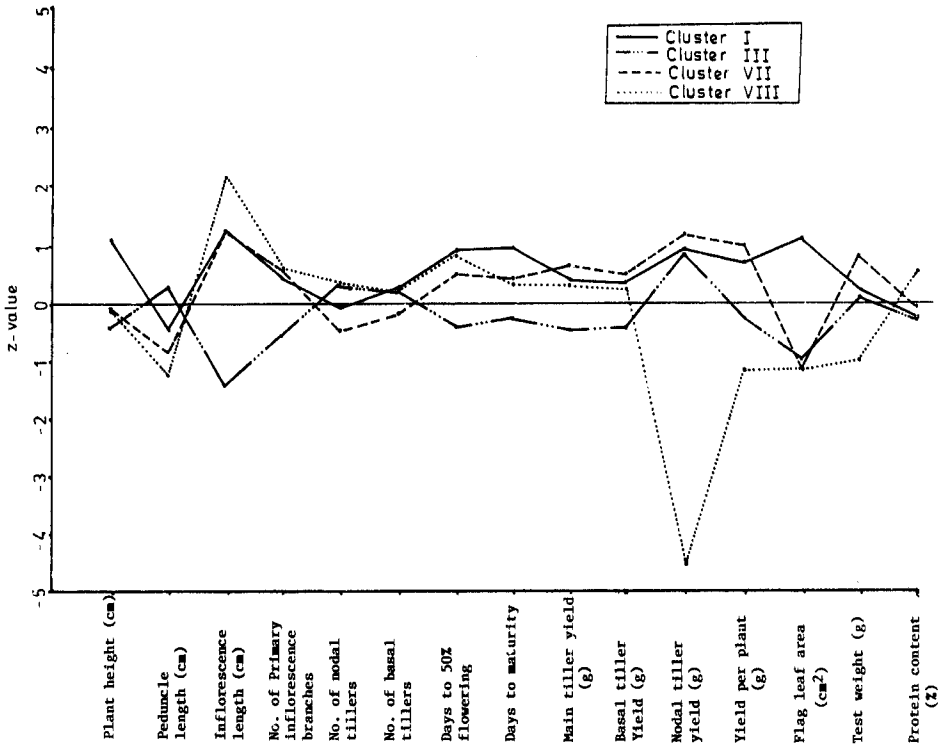

FIG. 1 : THE PATTERN OF DEVIATIONS OF MEANS OF FOUR CLUSTERS (Z values) FOR THE CHARACTERS

Table 3 : Mean values of the 15 characters for the 8 clusters

Characters / Clusters	Plant height (cm)	Ped-uncle length (cm)	Inflo-res-ence length	No. of primary Inflore-scence branches	No. of nodal tillers	No. of basal tillers	Days to 50% flower-ing	Days to matu-rity	Main tiller yield (g/pl)	Basal tiller yield (g/pl)	Nodal tiller yield (g/pl)	Yield (g/pl)	Flag leaf area (cm^2)	1000 grain weight (g)	Protein content (%)
I.	63.85	22.98	15.86	6.22	2.22	2.93	26.72	62.99	1.33	1.69	1.03	4.06	31.27	5.07	10.07
II.	93.61	12.10	24.02	7.90	3.05	4.35	36.05	73.38	1.80	4.86	1.76	8.60	31.99	5.38	9.65
III.	106.84	16.30	29.44	8.76	1.52	3.12	34.13	74.44	4.02	4.32	1.17	9.57	79.13	5.28	10.23
IV.	93.45	12.03	24.65	7.56	3.23	4.49	37.83	72.83	4.26	4.90	1.52	8.98	27.37	6.66	12.33
V.	110.01	20.79	30.24	10.58	0.78	4.28	33.25	77.75	6.00	2.59	0.67	9.26	82.70	5.45	7.47
VI.	103.18	13.12	30.31	6.94	1.87	3.63	34.00	80.50	1.47	2.47	4.80	8.27	41.05	5.70	9.29
VII.	98.00	26.45	15.51	5.60	3.00	4.25	26.00	68.00	0.51	1.25	0.55	2.31	82.25	3.95	9.69
VIII.	99.19	30.00	10.53	5.75	1.50	3.12	27.00	69.00	1.58	2.18	11.38	15.15	82.61	7.62	7.78
Mean	96.02	19.22	22.57	7.41	2.15	3.77	31.87	72.36	2.62	3.03	2.86	8.28	57.29	5.64	9.56
Variance	791.99	79.23	30.62	6.54	3.73	10.66	32.71	93.54	10.06	12.11	3.64	35.66	521.32	3.97	8.20
S.D.	28.14	8.90	5.53	2.56	1.93	3.26	5.72	9.67	3.17	3.48	1.91	5.97	22.83	1.99	2.86

inflorescence length, number of primary inflorescence branches, days to 50 per cent flowering, days to maturity, main tiller yield, nodal tiller yield, yield per plant, test weight and protein content and these were largely responsible for the genetic divergence. The plant height and basal tiller yield contributed little towards divergence.

Cluster analysis revealed certain relationship between genetic and geographic diversity. The Indian and USSR accessions forming solitary clusters VI, VII and VIII with accessions, GPms 385, BTS 3 and EC212545, respectively are genetically more diverse. The involvement of these accessions in the recombination breeding programme should be highly rewarding. Hybridization of selected USSR and Indian proso millet accessions may help in combining favourable yield contributing characters to have complementary effect on seed yield.

The promising accessions of potential breeding value for different traits are listed in table 4.

Table 4 : Promising accessions of proso millet for specific traits

	Traits		Accessions
1.	Tall plants	:	GPms 376, GPms 432
2.	Long inflorescence	:	GPms 370, GPms 374, GPms 375
3.	High primary inflorescence branches	:	GPms 361, GPms 370, GPms 374, GPms 375, GPms 392, GPms 482
4.	High nodal tillers	:	GPms 368, GPms 389, GPms 438
5.	High basal tillers	:	GPms 390, GPms 392, GPms 396, GPms 454, GPms 466
6.	Early duration	:	GPms 375, GPms 388
7.	Large flag leaf	:	GPms 378, GPms 373, EC212542
8.	Bold seeds	:	EC212545, GPms 353, GPms 466
9.	High protein	:	EC212495, EC212496, EC212529, GPms 389
10.	High nodal tiller yield	:	EC212545,
11.	High basal tiller yield	:	GPms 368, GPms 390
12.	High main tiller yield	:	EC212489, GPms 379, GPms 399
13.	High yield per plant	:	GPms 370, EC212545

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