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STUDIES ON GENETIC DIVERGENCE AND VARIABILITY IN PEARL-MILLET [*PENNISETUM GLAUCUM* (L.) R. BR. EMEND STUNTZ]

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SUMMARY

Fifty genotypes of pearl millet [*Pennisetum glaucum*] including three checks, namely, Raj.-171, ICIP-3616 and ICTP-8203 were evaluated for grain yield and its component characters in randomized block design with three replications during **kharif** 2007. The data were subjected to statistical analysis to obtain estimates of variability, heritability and genetic advance for different characters. Genetic divergence was carried out to judge the genetic diversity among the genotypes. The results indicated that the variability was significant for all the traits. Genetic divergence analysis revealed that genotypes could be grouped into 14 clusters. The genotypes of cluster IX had higher mean value for grain yield per plant, plant height, grain yield per plot and test weight, which can be used as parameters while selecting diverse parents for hybridization programme.

Key words : Genetic divergence, genetic variability, pearlmillet

Pearlmillet [*Pennisetum glaucum* (L.) R. Br. emend Stuntz] having chromosome no. 2n=14 is an annual allogamous crop belonging to the family Graminae. It is robust and quick growing rainy season cereal crop with large stem, leaves, heads, tall and vigour, with very high grain yield potential. In semi-arid tropical regions, it is cultivated as dual purpose crop when grown in a mono crop system. Whereas mature ears are harvested for grain and stover for bovine feed. In India pearl millet, while vernacular name of bajra, is grown in Rajasthan, Western part of Gujarat, Haryana and Western Uttar Pradesh. In the world, pearlmillet ranks sixth in importance following wheat, rice, maize, barley and sorghum. It is extensively cultivated as dual purpose crop over large part in Africa, Asia and Australia. India and Africa together account for 92.3 per cent of world bajra production. Production and productivity of pearl-millet in India are increasing inspite of reduction in area planted to this crop. It is the fourth most important food crop mostly grown in the arid and semi-arid regions, particularly in the north western parts of the country (Anonymous, 2007).

It is very palatable cereal with one of the best nutritional profiles (rich in tryptophane and cystine).The grains are husked and ground into flour to make porridge which are preferred by people over sorghum (Choudhary *et al.*, 2012). The straw of this crop is fairly rich in carbohydrates (67%). Some of other important quality aspects of forage are protein (11.6%), lignin, dry matter yield and its digestibility and oxalic acid content. Although crude protein content (9.9-14%) in pearlmillet stover is less than sorghum, but is more than wheat and rice. The toxic component HCN is less in flora of pearlmillet in comparison to sorghum.

MATERIALS AND METHODS

The experimental material for the present study consisted of 47 genotypes of diverse origin obtained from ICRISAT, Hyderabad and three checks, namely, Raj-171, ICTP-3616 and ICTP 8203 collected from Agricultural Research Station, Durgapura, Jaipur and were evaluated at Horticulture Research Farm, Asalpur-Jobner. All the 50 genotypes including checks were evaluated during **kharif** 2007 in randomized block design with three replications. In each replication, every genotype was sown in 4 m row spaced at 45 cm apart. Plant to plant distance of 15 cm was maintained by thinning/transplanting at 3-leaf stage. The crop was raised with recommended package of practices. Ten plants were randomly selected from each

genotype in each replication avoiding border plants. Every care was taken to select only competitive plants. Plants were tagged before initiation of earing for recording the observations on the following morphological characters at maturity except the days to heading. The data on days to heading were recorded on whole plot basis. The mean value of 10 plants for each character was computed and recorded as plot mean value for days to heading, plant height (cm), productive tillers per plant, spike length (cm), spike girth (cm), grain yield per plant (g), grain yield per plot (kg), harvest index (%), dry fodder yield per plant (g), test weight (g) and protein content (%).

RESULTS AND DISCUSSION

The analysis of variance indicated significant differences for all the characters (Table 1). It means that sufficient variability was present among genotypes. Similar results were also reported by Sagar (1999). The knowledge of genetic divergence provides us a sound scientific basis for selection of genotypes to be used in hybridization programme for further improvement (Chanderasekhariah *et al.* 1969). D^2 analysis was carried out to estimate genetic divergence among the 50 genotypes (47 germplasm lines and three checks) of pearlmillet. The generalized D^2 values were calculated for each pair of genotypes in all possible combinations. More than 82 per cent of the total D^2 values were found to be significant at 5 per cent probability level.

Cluster Composition

Grouping of 50 genotypes was done by Tocher method (Rao, 1952). All the genotypes were grouped into 14 clusters. Maximum number of genotypes were 16 which were included in Cluster II. Cluster I had 11 genotypes and Cluster VII had five genotypes. Cluster V had four genotypes and Clusters IX and XI had three genotypes, while Clusters III, IV, VI, VIII, X, XII, XIII and XIV had one genotype in each (Table 2).

Average Intra and Inter-cluster Divergence

The average intra and inter-cluster D^2 values are given in Table 3. Average intra-cluster D^2 value ranged from 0.00 to 36.61. Minimum average intra-cluster D^2 values of 0.00 were noted for clusters III, IV, VI, VIII, X, XII, XIII and XIV. Highest average intra-cluster values were recorded for Cluster VII (36.61) with five genotypes followed by Cluster XI (34.81) with three genotypes, Cluster V (33.53) with four genotypes, Cluster IX (31.59) with three genotypes, Cluster II (30.36) with 16 genotypes and Cluster I (21.72) with 11 genotypes. Average inter-cluster distance D^2 values ranged from 15.29 to 310.12. The minimum average inter-cluster D^2 value (15.29) was recorded between Clusters III and X. The maximum average inter-cluster D^2 value (310.12) was recorded between Clusters XII and XIV. This was followed by average inter-cluster D^2 value of 286.63 between Clusters V and XI. Another pair of cluster i. e.

TABLE 1
Analysis of variance for grain yield and its contributing traits in genotypes of pearlmillet

S. No.	Characters	Mean sum of squares		
		Replications (2)	Genotypes (49)	Error (98)
1.	Days to heading	13.167	64.114**	7.146
2.	Plant height (cm)	159.658	1067.694**	59.201
3.	Productive tillers/plant	0.049	0.789**	0.017
4.	Spike length (cm)	4.069	23.595**	1.660
5.	Spike girth (cm)	0.759	0.946**	0.309
6.	Grain yield/plant (g)	5.018	68.089**	2.504
7.	Grain yield/plot (kg)	0.001	0.050**	0.002
8.	Dry fodder yield/plant (g)	17.870	602.846**	16.034
9.	Test weight	0.085	16.281**	0.202
10.	Harvest index	1.271	31.887**	1.783
11.	Protein content (%)	0.094	1.584**	0.279

**Significant at P=0.01 level.

TABLE 2
Number of clusters along with the included genotypes

Cluster	Number of lines	Genotypes
I	11	IP-55-1, IP-470-1, IP-559-1, IP-533-1, IP-11-1, IP-442-2, IP-29-1, IP-27-1, IP-122-1, IP-526-1, IP-518-1
II	16	IP-9-1, IP-466-2, IP-521-1, IP-392-1, IP-196-1, IP-425-1, IP-65-1, IP-233-1, IP-285-1, IP-251-1, IP-200-1, IP-69-1, IP-79-1, IP-8, IP-95-1, IP-44-1
III	1	IP-15-1
IV	1	IP-409-1
V	4	IP-97-1, IP-418-1,IP-310-1,IP-272-1
VI	1	IP-438-2
VII	5	IP-2,IP-239-1,IP-38-1,IP-113-1,IP-298-1
VIII	1	IP-118-1
IX	3	IP-460-2,IP-503-1,IP-506-3
X	1	IP-382-1
XI	3	IP-111-1,IP-180-1,IP-400-1
XII	1	IP-181-1
XIII	1	IP-516-2
XIV	1	IP-532-1

Clusters VIII and XIV had average inter-cluster D^2 value of 262.44. Cluster IX had inter-cluster D^2 value (245.24) with cluster XIV. Cluster V had inter-cluster D^2 value (193.21) with cluster XIV. Cluster XI had inter-cluster D^2 value (189.06) with cluster XII. Cluster V had inter-cluster D^2 value (183.06) with cluster X. Cluster VII had inter-cluster D^2 value (180.91) with cluster VIII. Cluster IV had inter-cluster D^2 value 180.64 with Cluster XI. Cluster VI had inter-cluster D^2 value (180.37) with Cluster IX. Cluster IX had inter-cluster D^2 value (170.31) with Cluster XIII. Cluster I had (168.74) inter-cluster D^2 value with cluster XI which was 17^{th} in ranking of average inter-cluster distances. Cluster IV had average inter-cluster D^2 value of 168.23 with Cluster IX. Another average inter-cluster value had marginal difference between cluster.

Cluster Mean for Observed Characters

This cluster mean comparison indicated that Cluster IX had the highest mean value for grain yield per plant (34.59 g) followed by Cluster VII (33.90 g), XI (33.06 g), XII (32.75 g), X (32.01 g), II (29.79 g), III (28.10 g), I (24.42 g), XIV (23.07 g), XIII (22.65 g), VI (22.60 g), IV (22.49 g), V (22.11 g) and cluster (21.93 g), respectively. Cluster IX also had highest cluster mean value for grain yield per plot (0.87 kg), test weight (10.75 g) and plant height (169.92 cm). Cluster III had highest mean value for days to heading (70.67 days) only. Cluster VIII had highest mean value for productive tillers per plant (2.89), spike girth (7.93 cm) and protein content (11.67%). Cluster XIII had highest mean value for spike girth (30.07 cm) only. Cluster X had highest mean value for only one character i. e. dry fodder yield per plant (92.89 g). Cluster XII had highest cluster mean value for harvest index (35.43%) only. Remaining cluster mean values of various characters are given in Table 4.

Contribution of Characters Towards Total Divergence

Contribution of individual character towards total divergence relative contribution of various characters indicated that test weight had highest contribution (44.16%) followed by dry fodder yield per plant (24.98%) and productive tillers per plant (15.27%). While spike length (4.98%), plant height (4.41%), grain yield per plot (2.45%), harvest index (1.39%), days to heading (1.14%), protein content (0.82%), spike girth (0.24%) and grain yield per plant (0.16%) had low contribution towards total divergence. The characters viz., test weight, dry fodder yield per plant and productive tillers per plant were the major characters contributing traits total divergence (84.41%). Thus, these three characters are important and should be considered while selecting genetically diverse genotype.

TABLE 3
Average intra and inter-cluster distance and D^2 (parenthesis) values

Clusters	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	4.66 (21.72)	7.25 (52.57)	7.34 (53.88)	5.77 (33.30)	7.56 (57.16)	5.71 (32.16)	7.47 (55.81)	10.63 (112.99)	11.85) (140.43)	9.63 (92.74)	12.99 (168.74)	11.62 (135.03)	8.47 (71.74)	9.92 (98.41)
II		5.51 (30.36)	6.21 (38.57)	8.52 (72.60)	9.99 (99.80)	8.85 (78.33)	9.86 (97.22)	6.60 (43.56)	8.10 (65.61)	7.18 (51.56)	10.50 (110.25)	7.94 (63.05)	9.86 (97.22)	11.94 (142.57)
III			0.00 (0.00)	7.43 (55.21)	10.87 (118.16)	6.65 (44.23)	7.70 (59.30)	9.00 (81.00)	9.08 (82.45)	3.91 (15.29)	7.38 (54.47)	10.56 (111.52)	9.39 (88.18)	8.03 (64.49)
IV				0.00 (0.00)	6.76 (45.70)	5.59 (31.25)	5.43 (29.49)	11.93 (142.33)	12.97 (168.23)	10.86 (117.94)	13.44 (180.64)	12.10 (146.41)	5.29 (27.99)	9.38 (87.99)
V					5.79 (33.53)	9.48 (89.87)	9.02 (81.36)	12.51 (156.50)	14.93 (222.91)	13.53 (183.06)	16.93 (286.63)	11.63 (135.26)	8.91 (79.39)	13.90 (193.21)
VI						0.00 (0.00)	5.59 (31.25)	12.77 (163.08)	13.43 (180.37)	9.41 (88.55)	11.68 (136.43)	14.38 (206.79)	8.84 (78.15)	6.16 (37.95)
VII							6.05 (36.61)	13.45 (180.91)	14.54 (211.42)	10.59 (112.15)	12.95 (167.71)	13.99 (195.72)	8.99 (80.82)	7.90 (62.41)
VIII								0.00 (0.00)	5.68 (32.27)	9.03 (81.55)	11.71 (137.13)	4.79 (22.95)	12.25 (150.07)	16.20 (262.44)
IX									5.62 (31.59)	8.69 (75.52)	10.42 (108.58)	8.43 (71.07)	13.05 (170.31)	15.66 (245.24)
X										0.00 (0.00)	5.72 (32.72)	10.87 (118.16)	12.35 (152.53)	9.60 (92.16)
XI											5.90 (34.81)	13.76 (189.34)	14.42 (207.94)	10.82 (117.08)
XII												0.00 (0.00)	12.17 (148.11)	17.61 (310.12)
XIII													0.00 (0.00)	12.32 (151.79)
XIV														0.00

Diagonal values are intra-cluster estimates.

TABLE 4
Mean value of different clusters

Character	Clusters													
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
Days to heading	65.64	61.77	70.67	68.33	69.92	62.67	67.13	60.33	63.11	67.67	61.00	61.33	63.00	63.67
Plant height (cm)	129.31	134.68	131.30	139.93	101.12	133.0	128.43	155.00	169.92	125.27	133.90	123.77	150.10	132.33
Productive tillers/plant	2.71	2.66	1.85	2.03	2.75	1.97	1.70	2.89	2.69	2.09	1.53	2.98	1.86	1.34
Spike length (cm)	22.28	20.88	21.33	21.23	20.22	23.80	18.46	21.07	22.98	20.63	22.29	17.90	30.07	19.70
Spike girth (cm)	6.22	6.76	6.63	6.40	6.58	7.43	6.85	7.93	6.44	6.50	6.60	6.73	6.13	5.70
Grain yield/plant (g)	24.42	29.79	28.10	22.49	22.11	22.60	21.93	33.90	34.59	32.01	33.06	32.75	22.65	23.07
Grain yield/plot (kg)	0.58	0.71	0.63	0.58	0.52	0.53	0.52	0.81	0.87	0.73	0.84	0.85	0.53	0.52
Dry fodder yield/plant (g)	77.79	77.32	74.72	53.36	52.57	74.43	57.46	71.76	81.47	92.89	88.98	59.69	45.26	83.89
Test weight	5.81	8.45	7.97	4.23	4.65	4.69	4.64	10.60	10.75	9.90	9.87	10.47	4.70	5.04
Harvest index	24.06	28.02	27.35	29.70	29.54	23.30	27.84	32.08	29.75	25.63	27.06	35.43	33.33	21.54
Protein content (%)	10.34	10.41	10.07	9.46	10.31	10.68	10.61	11.67	9.64	10.83	10.87	10.74	9.68	9.31

CONCLUSION

On the basis of this investigation it can be concluded that hybridization programme should be carried out between genetically diverse parents IP-460-2, IP-503-1, IP-506-3, IP-118-1, IP-181-1, IP-15-1, IP-382-1 and IP-516-2 which may provide good base material for developing high yielding varieties through population improvement methods. Inbreds can also be developed from this base material.

REFERENCES

Anonymous, 2007 : Report of Directorate of Statistics, Department of Agriculture and Co-operation. Ministry of Agriculture, Govt. of India.

Chandrasekhariah, S. R., B. R. Murty, and V. Arunchalam, 1969 : *Proc. National Institution Science*, **35** : 172-195.

Choudhary, R., B. L. Jat, R. Anwala, S. R. Dhikwal, and K. C. Sharma, 2012 : *Forage Res.*, **38** : 80-85.

Rao, C. R. 1952 : *Advanced Statistical Methods in Biometrical Research.* John Wiley and Sons, Inc., New York.

Sagar, P. 1999 : Symp. on Pearlmillet Improvement–Past Achievements and Future Priorities. CCS Haryana Agricultural University, Hisar. pp. 33.