Int.J.Curr.Microbiol.App.Sci (2018) Special Issue-6: 956-961

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7692 **Special Issue-6 pp. 956-961**
Journal homepage: http://www.ijcmas.com

Original Research Article

Combining Ability for Grain Yield and Its Related Traits in Pearl Millet (*Pennisetum glaucum* L.)

S. B. Badurkar, S. P. Pole, V. N. Toprope and N. P. Ingle*

Department of Agricultural Botany, College of Agriculture, Latur-413 512 (M.S.), India
Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani-431 402 (M.S.), India
**Corresponding author*

Keywords

Pearl millet, combing ability, GCA, SCA, gene action

A B S T R A C T

Significant mean sum of squares due to GCA and SCA were significant for all the traits suggesting that additive and non-additive component of gene action. The ratio of σ^2 GCA/ σ^2 GCA was less than unity for all the traits indicated the preponderance of non-additive gene effects in the expression of these traits. The CGMS line MS 92888, MS 95111 and restorer parent R 156 and R 177 were found good general combiners for grain yield and other related traits. In general for grain yield and its related traits the hybrids *Viz.*, MS 95111 x R 189 and MS 93333 x R 177 with high mean performance, significant standard heterosis and significant sca value were appeared to be promising cross combinations for actual exploitation and could be recommended for testing over in multilocation trials.

Introduction

Pearl millet (*Pennisetum glaucum* (L) R. Br.) is world's sixth and India's fourth important cereal food crop after rice, wheat and maize. It is commonly known as pearl millet, cat tail, spiked or bulrush millet and locally known as Bajara. Pearl millet is not only a quick growing short duration crop, but also a high tillering, drought and heat tolerant and well adapted to different soil types. Because of its propensity for high dry matter production at high temperature, it has made a mark in tropics and sub-tropics. In India, Pearl millet occupies an area of 7.8 million hectares with production of 9.25 million tones and productivity of 1270 kg/ha (Anonymous, 2016). The major growing states in India are Rajasthan, Maharashtra, Gujarat, Punjab, Haryana and Utter Pradesh, where, it is grown both in *Kharif* and summer seasons.

The breeding improvement work in Pearl millet in earlier days was neglected since, it was considered to be a crop in India. The crop improvement work in this crop was initiated in India from 1920, but the real breakthrough made when the first and most widely used cytoplasmic male sterile line, Tift 23 was released (Burton, 1968) which permitted commercial hybrids to be developed in India. With the production and extensive testing of single crosses with Tift

23 A, Indian breeders were able to announce the release of first HB-1 commercial hybrid in 1965 (Athwal, 1965). Then after newly several cytoplasmic genetic male sterility sources viz., A1, A4, A 5, available in pearl millet have facilitated the production and release of a number of hybrids.

Exploitation of hybrid vigour is considered to be one of outstanding achievement of plant breeding in this crop. Cross pollinated nature and availability of male sterile line in pearl millet had made its feasible use to exploit hybrid vigour on commercial scale. The combining ability studies provides useful information regarding the selection of suitable parents for effective hybridization programme and at the same time elucidates the nature and magnitude of different types of gene action.

Since, the nature of gene action varies with genetic architecture of population involved in hybridization, it is necessary to evaluate the parents for their combining ability Based on these considerations, hybrids made by crossing of these parents in line x tester mating design were evaluated along with parents and checks to assess the combining ability of the parents and hybrids Hence, the present investigation was undertaken to study the magnitude of components of genetic variance through combing ability analysis, general combining ability of parents and specific combing ability of hybrids.

Materials and Methods

The experimental material for the present investigation was generated by crossing four CGMS lines *Viz.*, MS 93333, MS 94444, MS 95111, MS 92888 obtained from NARP, Aurangabad with 5 restorer pollinators *viz.***,** AIB 157, R 189, R 177, R 169 and R 156 developed at Experimental Farm, Department of Agricultural Botany, College of Agriculture, Latur in line x tester manner during Summer 2016. Nine parents, 20 hybrids and 2 checks (AHB 1666 and Mahabeej RB) were evaluated in Randomized block design with two replications at Experimental Farm, Department of Agricultural Botany, College of Agriculture, Latur during *Kharif* 2016.

All the recommended agronomic practices and plant protection measures followed time to time to raise the good crop. Five competitive plants from each experimental units of every replication were randomly selected for recording observation for ten characters *viz.*, days to 50% flowering, days to maturity, plant height (cm), total number of tillers per plant, number of effective tillers per plant, 1000 seed weight (g), ear head girth (cm), ear head length (cm), fodder yield per plant (g) and grain yield per plant (g). The observation s taken for hybrids and parents were subjected to line x tester analysis. The general combining ability effects of parents and specific combing ability effects of different crosses were worked out. The combining ability variances analysis was carried out based on method developed by Kempthorne (1957).

Results and Discussion

The analysis of variance for combing ability (Table 1) revealed that mean sum of squares due to GCA and SCA were significant for all the traits suggesting that additive and non-additive component of gene action. The ratio of σ^2 GCA/ σ^2 GCA was less than unity for all the traits, there by indicating the preponderance of non-additive gene effects in the expression of these traits. These results are in accordance with the findings of Manga and Dubey (2004), Dangariya *et al.*, (2009), Bachkar *et al.*, (2014) and Chittora and Patel (2016).

Table.1 Analysis of variance for combining ability for different characters in pearl millet

Source of variation	d.f	Days to 50 % flowering	Days to maturity	Plant height	Number of tillers per plant	Effective tillers per plant	1000 seed weight	Ear head girth	Ear head length	Fodder yield per plant	Grain yield per plant
Replications	1	0.431	0.011	59.04	0.033	0.00003	0.230	98.358**	26.170**	44.851	16.740
Lines	3	0.458	3.318	875.693**	0.200	0.040*	2.132*	5.716	0.535	47.148	23.211
Testers	4	3.150	2.066	3.903	0.946	0.144**	2.856**	0.297	9.211	34.012	3.967
Line x Testers	12	0.022	2.272	17.813**	0.256	0.001	6.259**	4.140	6.913	23.901	0.507
Error	19	6.0736	2.4367	92.06	0.2683	0.01001	0.6159	2.5973	3.3115	21.797	8.80
σ^2GCA	-	1.2318*	0.6932*	62.7902	0.0676*	0.0245**	0.0352	0.2883*	-0.0045	7.2674	0.2876
σ^2SCA	-	1.9410	1.3414	412.029**	0.1385*	0.0322**	1.2745**	-0.0630	3.8919*	84.6206**	34.3929**
σ^2GCA/ σ^2GCA	-	0.6346	0.5168	0.1523	0.4883	0.7615	0.0276	-4.5750	-0.0012	0.0859	0.0084

*and ** indicated significance at 5 and 1 per cent respectively.

Table.2 Estimates of general combining ability (GCA) effects for ten characters in pearl millet

Sr. No.	Crosses	Days to 50% flowering	Days to maturity	Plant height	No. of tillers/ plant	Effective tillers per plant	1000 seed weight	Ear head girth	Ear head length	Fodder yield per plant	Grain yield per plant
Lines											
1	MS 93333	0.900	1.575 *	6.682	0.395 **	0.194 **	-0.099 **	-1.288 **	-0.768 **	-4.361	-1.073 **
2	MS 94444	1.400	-0.165 **	2.392	-0.285 **	0.044 **	-0.096 **	0.168	-0.039 **	-0.206	0.024
3	MS 95111	-1.500 **	-0.965 **	2.313	-0.245 **	-0.026 **	-0.320 **	0.648	0.718	1.657	0.170
4	MS 92888	-0.800 **	-0.445 **	-11.388 **	0.135 *	-0.212 **	0.514 *	0.472	0.089	2.911	0.879
Testers											
5	AIB -157	-0.025 **	0.550	-3.705 **	-0.120 **	-0.076 **	-0.353 **	-0.694 **	1.080	1.218	0.626
6	R 189	1.725	0.600	-2.992 **	-0.345 **	-0.151 **	0.180	-0.034 **	-0.523 **	-0.836	-0.455 **
7	R 177	0.600	-1.525 **	14.283	-0.045 **	0.174 **	0.327	0.186	-0.216 **	-1.686	0.821
8	R 169	-0.775 **	-0.100 **	2.082	0.180 *	-0.096 **	0.110	-0.172 **	-0.122 **	-3.085	-2.039 **
9	R 156	-1.525 **	0.475	-9.668 **	0.330 **	0.149 **	-0.264 **	0.714	-0.219 **	4.389	1.047
S.E. Gi- Gj (Line)		0.960	0.780	3.697	0.196	0.048	0.366	0.684	0.830	1.941	1.199
S.E. Gi- Gj (Testers)		1.073	0.872	4.134	0.220	0.054	0.409	0.765	0.928	2.170	1.341
C. D.1% (Line)		**1.94**	**1.579**	**7.480**	**0.398**	**0.098**	**0.741**	**1.385**	**1.679**	**3.927**	**2.42**
C. D.1% (Testers)		**2.171**	**1.765**	**8.363**	**0.445**	**0.109**	**0.828**	**1.548**	**1.878**	**4.391**	**2.713**

*, ** Significant at 5 and 1 per cent level, respectively.

Table.3 Estimates of specific combining ability (SCA) effects for ten characters in pearl millet

Sr. No.	Crosses	Days to 50% flowering	Days to maturity	Plant height	No. of tillers/ plant	Effective tillers per plant	1000 seed weight	Ear head girth	Ear head length	Fodder yield per plant	Grain yield per plant
1	MS 93333 × AIB -157	2.725	-0.050	19.705 **	-0.520	-0.094	-0.231	-1.022	3.421 *	1.379	-0.427
2	MS 93333 × R189	-1.025	0.700	-32.658 **	0.505	0.181 *	-0.879	0.848	-0.442	-4.027	-1.046
3	MS 93333 × R 177	-0.900	-3.275 *	26.968**	0.305	-0.144	-0.121	-0.802	-0.740	4.183	6.368 **
4	MS 93333 × R 169	-0.025	1.100	7.067	-0.620	-0.174 *	0.986	0.216	-1.383	2.917	-0.797
5	MS 93333 × R 156	-0.775	1.525	-21.083**	0.330	0.231 **	0.245	0.761	-0.856	-4.452	-4.098 *
6	MS 94444 × AIB -157	1.225	-1.010	-18.055**	0.260	0.056	-0.269	1.702	-1.069	7.735 *	4.971 *
7	MS 94444 × R 189	-0.025	1.640	-0.567	-0.115	-0.069	2.093 **	-1.158	-1.546	-11.79 **	-8.658 **
8	MS 94444 × R 177	0.600	1.165	-3.043	-0.115	0.206 *	-2.034 **	-1.158	2.427	1.614	-1.599
9	MS 94444 × R 169	-0.025	-1.760	13.358 *	0.060	-0.124	0.513	-0.141	-0.957	-0.477	2.761
10	MS 94444 × R 156	-1.775	-0.035	8.307	-0.090	-0.069	-0.303	0.754	1.145	2.919	2.525
11	MS 95111 × AIB -157	-1.875	0.090	-0.275	0.420	0.026	-0.685	-0.098	-0.001	1.602	1.335
12	MS 95111 × R 189	-0.625	-0.660	18.413 **	0.145	-0.099	0.492	0.342	0.812	10.826**	8.151 **
13	MS 95111 × R 177	2.500	2.065	-24.063 **	-0.155	0.176 *	1.000	0.672	-0.211	-18.90 **	-10.97**
14	MS 95111 × R 169	-2.125	-0.560	6.638	-0.380	-0.054	-0.808	-0.401	-2.164	0.435	1.460
15	MS 95111 × R 156	2.125	-0.935	-0.712	-0.030	-0.049	0.001	-0.515	1.563	6.046	0.029
16	MS 92888 × AIB -157	-2.075	0.970	-1.375	-0.160	0.012	1.186	-0.582	-2.352	-10.71 **	-5.87 **
17	MS 92888 × R 189	1.675	-1.680	14.813 *	-0.535	-0.013	1.707 **	-0.032	1.176	4.992	1.552
18	MS 92888 × R 177	-2.200	0.045	0.137	-0.035	-0.238 **	1.156	1.288	-1.477	13.11 **	6.206 **
19	MS 92888 × R 169	2.175	1.220	-27.063 **	0.940 **	0.352 **	-0.692	0.326	4.505 **	-2.874	-3.424
20	MS 92888 × R 156	0.425	-0.555	13.488 *	-0.210	-0.113	0.057	-1.000	-1.853	-4.513	1.545
	CD at 1 %	4.343	3.531	16.72	0.890	0.2199	1.657	3.097	3.755	8.783	5.426

*, ** Significant at 5 and 1 per cent level, respectively.

Table.4 Estimates of mean grain yield, standard heterosis and sca effect for bets five hybrids

Characters	Crosses	Sca effect	Per se performance of hybrids	Standard heterosis (%) over		GCA effects		GCA status
				AHB 1666	Mahabeej RB	Line	Tester	
Grain yield per plant	MS 92888 × R 177	6.206**	53.37	28.46**	25.58**	0.879	0.821	A x A
	MS 95111 × R 189	8.151**	53.33	28.37**	25.48**	0.170	-0.45**	A x L
	MS 93333 × R 177	6.368**	51.58	24.15**	21.36**	-1.07**	0.821	L x A
	MS 94444 × AIB -157	4.97*	51.08	22.96**	20.20**	0.020	0.626	A x A
	MS 94444 × R 156	2.525	49.05	18.09*	15.44*	0.024	1.047	A x A

*, ** Significant at 5 and 1 per cent level, respectively.

General combing ability effects

The estimates of GCA effects (Table 2) revealed that the CGMS line MS 92888 was the good general combiner for grain yield per plant. It also had significantly desirable GCA effects for total number of tillers per plant, 1000 seed weigh, days to 50 per cent flowering and days to maturity. The line MS 95111 was good combiner for plant height, ear head girth, ear head length, fodder yield per plant and grain yield per plant. The restorer parent R 156 was good combiner for total number of tillers per plant and effective tillers per plant. Earliness is desirable the lines having negative GCA effect for this trait are important in breeding programme.

In the present investigation, the CGMS line MS 95111, MS 92888 and restorer parent R 177 and R 169 were found good combiner for days to maturity. In the present study CGMS lines MS 93333 and MS 92888 were found good combiner for total number of tillers as it contributes to fodder yield per plant and the lines MS 93333 and MS 94444 were found good combiner for effective tillers as it contributes to grain yield per plant. The CGMS line MS 92888 (0.87), MS 95111 (0.17), and MS 94444 (0.02) and three restorer parents *viz,* R 156 (1.04), R 177 (0.82) and AIB -157 (0.62) found good combiner for grain yield per plant. Significant GCA effects for these character were also recorded by Kathale *et al.,* (2013), Khan and Dubey (2015), Nandaniya *et al.,* (2016) and Patel *et al.,* (2016)

Specific combing ability effects

The estimates of specific combing ability (Table 3) effect by enlarge provide information on role of non-additive gene action (intra and inter-allelic interactions) in the expression of heterosis. The results narrated in table 3 revealed that out 20 crosses, 12 F_1 crosses evaluated 4 F_1s *viz.*, MS 95111x R 189, MS 93333 x R 177, MS 92888 x R 177 and MS 94444x AIB 157 registered significant and positive sca effects for grain yield per plant. None of the crosses depicted desirable sca effects for all the characters.

In the present investigation, the best five hybrids based on the mean grain yield per plant aling with the standard heterosis over the check hybrids AHB 1666 and Mahabeej RB were compared for their sca effects and gca effects of corresponding parents (Table 4). The different estimates revealed that the best performing hybrids with high mean grain yield and positive significant sca effects for grain yield generated from average x low general combiner parent. The involvement of at least one good general combiner was also reported by Navale *et al.,* (1991), Joshi *et al.,* (2000) and Chittora and Patel (2016).

The crosses with significant standard heterosis involving high average x average or average x poor general combiner parents indicate dominance type of gene action. For grain yield per plant, these hybrids with high *per se* performance and significant sca effects involved average x average or average x poor general combiner indicating the significance of epistatic gene action in governing this trait. It is in conformity with the results of Joshi eta l (2000) and Chittora and Patel (2016). The present study indicated that the hybrids MS 95111 x R 189 and MS 93333 x R 177 had high mean grain yield per plant and standard heterosis over both the checks AHB 1666 and Mahabeej RB as the significant outcome of the study on heterosis and combining ability. Hence these two hybrids appear to be very promising combination for actual exploitation and could be recommended for testing in multilocation trials.

References

Anonymous, 2016. Ministry of Indian Agriculture, All India Coordinated Research Project on Pearl Millet (Pearl Millet News) *www.google.com*, pp: 1-7.

Athwal, D.S. 1965. Hybrid Bajara 1 marks a new era. *Indian Farming*, 15:6-7.

Bachkar, R. M., Pole, S.P., and Patil, S.N. 2014. Heterosis for grain yield and its components in pearl millet (*Pennisetum glaucum* L.). *Indian J. Dryland Agric. Res. Dev.,* 29 (1): 40-44.

Burton, G. W. 1965. Pearl millet Tift 23A released. *Crops and Soil,* 17: 19.

Chittora Khushbu, and Patel, J.A. 2016. Combining ability for seed yield and yield component characters in pearl millet [*Pennisetum glaucum* (L). R. Br.]. *The bioscan*., 11(3): 1905-1911.

Dangariya, C. J., Chotalia, J. M., Savaliya, J. J., Davda, B. K. and Pansuriya, A. G. 2009. Combining ability analysis in pearl millet [*Pennisetum glaucum* (L). R. Br.]. *Agril. Sci. Digest*. 294: 287-290.

Joshi, H. J., Dhaduk, H. L., Mehata, D. R. and Pethani, K. V. 2000. Line x Tester analysis over environment in pearlmillet (*Pennisetum glaucum* (L.) R. Br). *Agric. Sci. Digest*. 20(4): 244-247.

Kathale, M.N., Gadakh, S.S., and Dethe A.M. 2013. Line x testers analysis in pearl millet (*Pennisetum Glaucum* L.). *Bio infolet*. 10 (2):448-452.

Kempthrone, O. 1957. An introduction to genetic statistics. John Willey and Sons. Inc., New York.

Khan, R. and Dubey, R. B., 2015. Combining ability analysis for nutritional quality and yield in maize (*Zea mays* L.). *The bioscan*. 10(2): 785-788.

Manga, V. K. and Dubey, L. K. 2004. Identification of suitable inbreds based on combining ability in pearl millet (*Pennisetum glaucum*). *Indian J. Agric. Sci*. 742: 98-101.

Nandaniya, K.U., Mungra, K.D., and Sorathiya, J.S. 2016. Assessment of combining ability for yield and micronutrients in pearl millet. *Electronic J. Plant Breeding*, 7 (4): 1084-1088.

Navale, P. A., Kanade, B. C., Sarawate, C. D. and Harinarayana, G. 1991. Combining ability analysis of newly developed male sterile lines and restorer in pearl millet. *J. Maharashtra Agril. Uni.* 16(1): 17-19.

Patel, B.C., Patel, M.P. and Patel, J.A. 2016. Combining ability studies for grain yield and its components in pearl millet (*Pennisetum glaucum* [L.] R.Br.). *Electronic J. Plant Breeding*, 7(3): 595601.