



Research Article

COMBINING ABILITY ANALYSIS IN DESIGNATED R-LINES OF PEARL MILLET (*Pennisetum glaucum*)

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Abstract: In present experiment 3 lines, 14 testers and 42 hybrids were used to studies combining ability at three locations during kharif 2016. Analysis of variance for combining ability indicated that the mean sum of squares due to lines, testers and line x tester were found significant for days to 50% flowering and plant height. General combining ability effects suggested that ICMR 13111, ICMR 13333 and ICMA 92777 were found to be the best general combiners for earliness whereas, ICMR 13666, ICMA 04888 and ICMA 04999 were good general combiners for lateness. ICMR 14444, ICMR 14999 and ICMR 14888 were found to be positive significant GCA effects for plant height. The SCA estimates revealed that no cross combination was consistently superior for all four characters under study. ICMA 92777 x ICMR 13555 cross was only identified as the best specific combiners for yield. ICMA 04888 x ICMR 13666, ICMA 04888 x ICMR 14888 and ICMA 92777 x ICMR 14444 crosses showed highest SCA values for days to 50% flowering in negative direction that can be used for earliness, whereas ICMA 04888 x ICMR 13666, ICMA 04999 x ICMR 13777, ICMA 92777 x ICMR 14111 and ICMA 92777 x ICMR 14555 showed positive significant SCA effects for plant height.

Keywords: Line x tester, Combining ability, Gene action, R-lines, Pearl millet

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Introduction

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is the sixth most important crop globally, and is an important crop for Indian agriculture after rice, wheat and maize in terms of total cropped area[1]. Pearl millet is the staple food of majority of the poor and small land holders, as well as feed and fodder for livestock in rainfed regions of the country. Pearl millet excels all other cereals due to its unique features - C₄ plant with high photosynthetic efficiency, high dry matter production capacity and in most adverse agro climate situations it grows well where crops like maize and sorghum not able to produce good amount of economic output because its required less input and short maturation period. It is source of nutritious food, feed and fodder. It is grown on 7.5 million ha with an average production of 9.73 million ton and productivity of 1305 kg/ha during 2016-17 [2]. Pearl millet is rightly termed as “nutricereal” as it is a good source of energy, carbohydrate, protein, fat, ash, dietary fibre, iron and zinc by Satyavathi et al.[3]. For boosting per unit yield through genetic improvement, the selection of suitable parents is very crucial. Information about genetic architecture is the best tool for the selection of best parents. Combining ability analysis (CAA) is one of the best techniques for exploring the genetic mechanism of crop plants [4-6]. Testing the parents for their combining ability is very important because many times the high yielding parents may not combine well to give good hybrids. Line x tester analysis helps in testing a large number of genotypes to assess the gene action and combining ability. Such study also elucidates the genetic variability which can successfully be used in future hybridization programs. Equipped with such information, a breeder can select desirable parents which when crossed would produce best performing segregates [4]. This technique also provides information to choose an appropriate and efficient breeding scheme for selection in the segregating population. The present study was, therefore, under taken to identify and assess the pattern of inheritance of grain yield and other quantitative traits and to select the parents having good GCA and cross combinations with good SCA values through line x tester analysis in pearl millet.

Material and Methods

The present study on pearl millet was conducted under ICAR-ICRISAT partnership project. Fourteen diverse designated R-lines viz., ICMR 13111, ICMR 13333, ICMR 13555, ICMR 13666, ICMR 13777, ICMR 13888, ICMR 14111, ICMR 14222, ICMR 14333, ICMR 14444, ICMR 14555, ICMR 14777, ICMR 14888 and ICMR 14999 were crossed with three A-line viz., ICMA 04888, ICMA 04999 and ICMA 92777 in a line x tester mating design. The resulted 42 hybrids along with 17 parents were evaluated in separate block during kharif 2016 in a Randomized Block Design with two replications across environmentally different three locations- Dhule, Jaipur and Gwalior. Each plot with a spacing of 60 x 15 cm consisted of two rows of 4.0 m length. All need based agronomic practices were followed during the crop growth period to raise a good crop. Observations were recorded on randomly selected five plants in each plot for 3 quantitative traits viz., days to 50% flowering, plant height (cm) and number of effective tillers per plant. Grain yield was recorded per plot (g). The mean values were used for the analysis of variance for experimental design. The data were statistically analyzed for combining ability as per the method suggested by Kempthorne[7].

Result and Discussion

Analysis of variance for combining ability

The results of ANOVA for combining ability indicated that the sum of mean square due to lines, testers and line x tester were found highly significant for days to 50% flowering and plant height, whereas the sum of mean square due to treatment were found highly significant for all four characters under study [Table-1].

Estimates of general combining ability effects

General combining ability effects suggested that ICMR 13111, ICMR 13333 and ICMA 92777 were found to be the best general combiners for earliness whereas, ICMR 13666, ICMA 04888 and ICMA 04999 were good general combiners for lateness.

Table-1 Analysis for combining ability for 4 traits in Pearl millet (Mean sum of square) based on fixed effect model

SN	Source	D.F.	Days to 50% flowering (No.)	Plant height (cm)	Effective tillers/plant (No.)	Grain yield (Kg)
1	Replication (Location)	3	94.6	95.2	94.6	94.0
2	Tester	13	173**	108**	116	126
3	Line	2	173**	108**	116	126
4	Line x Tester	26	172*	108**	116	126
5	Location	2	115**	105**	105**	108.0 **
6	Treatment	58	172**	108**	116*	126**
7	Error	96	71.2	88.1	83.8	83.3

**, *Significant at 1% and 5% level respectively

Table-2 Estimates of general combining ability effects of parents for 4 traits in Pearl millet

SN	Parents	Days to 50% flowering (No.)	Plant height (cm)	Effective tillers/plant (No.)	Grain yield (Kg)
	Tester (Males)				
1	ICMR 13111	-2.12**	2.89	0.06	133.75
2	ICMR 13333	-1.12**	3.78	-0.11	-169.41
3	ICMR 13555	0.17	0.73	-0.02	-324.14
4	ICMR 13666	1.77**	-12.17**	0.06	-40.8
5	ICMR 13777	0.01	-6.24	-0.09	-276.73
6	ICMR 13888	-0.17	-4.89	0.06	-74.69
7	ICMR 14111	-0.23	-6.44	-0.17	306.98
8	ICMR 14222	0.27	-4.5	0.17	69.2
9	ICMR 14333	0.61	2.11	0.06	484.2
10	ICMR 14444	0.11	11.00**	-0.11	-220.52
11	ICMR 14555	0.05	-9.05**	-0.01	-13.86
12	ICMR 14777	0.38	0.39	-0.06	-4.41
13	ICMR 14888	0.04	6.78*	0.17	183.75
14	ICMR 14999	0.22	15.61**	0	-53.3
	SE (g)	0.41	3.45	0.12	259.28
	SE (g.g)	0.57	4.88	0.16	366.67
	Line (Female)				
1	ICMA 04888	1.00**	-4.44**	-0.05	-15.76
2	ICMA 04999	0.43*	2.37	0.08	70.39
3	ICMA 92777	-1.43**	2.07	-0.03	-54.63
	SE (g)	0.19	1.60	0.05	120.02
	SE (g.g)	0.27	2.26	0.08	169.74

**, *Significant at 1% and 5% level respectively

ICMR 14444, ICMR 14999 and ICMR 14888 were found to be positive significant GCA effects for plant height but for other two traits it is not a good general combiner. ICMR 14333 showed highest GCA effects in positive direction for grain yield followed by ICMR 14111, ICMR 13111 and ICMR 14888 [Table-2].

Estimates of specific combining ability effects

The SCA effect estimates revealed that no cross combination was consistently superior for all four characters under study [4, 8-10]. One cross *i.e.* ICMA 92777 x ICMR 13555 was identified as the good specific combiners for grain yield. ICMA 04888 x ICMR 13666, ICMA 04888 x ICMR 14888 and ICMA 92777 x ICMR 14444 crosses showed significant negative SCA values for days to 50% flowering that can be used for earliness, whereas ICMA 92777 x ICMR 14111, ICMA 92777 x ICMR 14555, ICMA 04999 x ICMR 13777 and ICMA 04888 x ICMR 13666 showed positive significant SCA effects for plant height. For the trait effective tillers per plant only two crosses *viz.*, ICMA 04999 x ICMR 14777 and ICMA 04888 x ICMR 13555 were having significant positive SCA effects [Table-3]. Analysis of SCA effects revealed that good combining parents yield better hybrids because parents with significant positive GCA effect were involved more in selected crosses than those with non-significant GCA effects and negative GCA effects. Several workers have also made similar results in pearl millet [11-13].

Conclusion

For the earliness, ICMR 13111, ICMR 13333 and ICMA 92777 entries were found best general combiners and for grain yield ICMA 92777 x ICMR 13555 cross was identified as the good specific combiner.

Application of research: It will be helpful for pearl millet breeders for development of new high yielding hybrids and varieties. Study of SCA effects revealed that good combining parents yield better hybrids

Research Category: Plant Breeding and Genetics.

Abbreviations: GCA: general combining ability, SCA: specific combining ability, ICMR: ICRISAT millet restorer, ICMA: ICRISAT millet A-line.

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Table-3 Estimates of specific combining ability effects of crosses for 4 traits in Pearl millet

SN	Crosses	Days to 50% flowering	Plant height	Effective tillers/plant	Grain yield
1	04888 A X ICMR 13111	0.33	-1.95	-0.01	-51.85
2	04888 A X ICMR 13333	0.66	2.83	0.16	106.32
3	04888 A X ICMR 13555	-0.12	11.55	0.40*	353.54
4	04888 A X ICMR 13666	-1.73*	12.44*	-0.01	359.37
5	04888 A X ICMR 13777	0.37	2.68	-0.03	-163.03
6	04888 A X ICMR 13888	0.72	1.49	0.16	103.26
7	04888 A X ICMR 14111	0.77	6.05	0.05	81.6
8	04888 A X ICMR 14222	0.11	-1.56	0.05	-283.13
9	04888 A X ICMR 14333	-0.89	-17.51**	0.16	58.54
10	04888 A X ICMR 14444	1.27	-2.89	-0.01	511.6
11	04888 A X ICMR 14555	1	-11.51	-0.3	-374.24
12	04888 A X ICMR 14777	-0.5	-5.45	-0.23	-727.01
13	04888 A X ICMR 14888	-1.49*	1.66	-0.28	333.15
14	04888 A X ICMR 14999	-0.5	2.16	-0.12	-308.13
15	04999 A X ICMR 13111	-0.1	2.07	-0.14	508.66
16	04999 A X ICMR 13333	-0.43	-3.31	-0.14	-312.34
17	04999 A X ICMR 13555	-0.38	5.24	-0.06	761.56
18	04999 A X ICMR 13666	0.52	7.63	0.36	-13.45
19	04999 A X ICMR 13777	-0.56	14.04*	0	-10.02
20	04999 A X ICMR 13888	0.13	-11.15	-0.14	-697.06
21	04999 A X ICMR 14111	-0.48	-31.26**	-0.08	-114.56
22	04999 A X ICMR 14222	-0.15	-4.87	-0.25	6.55
23	04999 A X ICMR 14333	-0.48	10.02	0.03	-325.95
24	04999 A X ICMR 14444	0.18	3.13	0.03	38.78
25	04999 A X ICMR 14555	-0.26	-2.65	0.09	-67.06
26	04999 A X ICMR 14777	-0.1	5.41	0.47*	266.83
27	04999 A X ICMR 14888	1.38*	6.35	-0.08	-524.34
28	04999 A X ICMR 14999	0.74	-0.65	-0.08	482.39
29	92777 A X ICMR 13111	-0.23	-0.12	0.15	-456.82
30	92777 A X ICMR 13333	-0.23	0.49	-0.02	206.02
31	92777 A X ICMR 13555	0.5	-16.78**	-0.34	-1115.10*
32	92777 A X ICMR 13666	1.21	-20.07**	-0.35	-345.93
33	92777 A X ICMR 13777	0.19	-16.72**	0.03	173.06
34	92777 A X ICMR 13888	-0.85	9.65	-0.02	593.8
35	92777 A X ICMR 14111	-0.29	25.21**	0.03	32.96
36	92777 A X ICMR 14222	0.04	6.43	0.2	276.57
37	92777 A X ICMR 14333	1.38	7.49	-0.19	267.41
38	92777 A X ICMR 14444	-1.46*	-0.24	-0.02	-550.37
39	92777 A X ICMR 14555	-0.73	14.15*	0.21	441.3
40	92777 A X ICMR 14777	0.6	0.04	-0.24	460.18
41	92777 A X ICMR 14888	0.11	-8.01	0.37	191.19
42	92777 A X ICMR 14999	-0.23	-1.51	0.2	-174.26
	SE (s _{ij})	0.70	5.98	0.20	449.08
	SE (s _{ij} , s _{ij})	1.99	16.90	0.57	1270.19

**, *Significant at 1% and 5% level respectively