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Assessment of Combining Ability and Gene Action in Pearl Millet (*Pennisetum glaucum* (L.) R. Br.) Using Line X Tester Analysis

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ABSTRACT

A line x tester analysis using four lines and twelve testers was carried out to study the combining ability and gene action for grain yield and other morpho-nutritional traits in pearl millet. Analysis of variance for combining ability revealed that significant differences among the mean squares was observed for lines, testers and lines x testers for all the characters except for mean squares due to lines for days to 50 % flowering, days to maturity, ear head girth, number of grain per sq.cm, grain Zn content (mg/kg) and due to testers for grain Fe content (mg/kg). Among the lines, DHLB-18A and the testers K-13/991, K-13/999 and K-13/1005 displayed high GCA effect for grain yield per plant and for some desirable traits. Significant and positive SCA effect for grain yield per plant was displayed by the cross DHLB-17A x K-13/1005 (average x good), followed by DHLB-16A x K-13/1008, DHLB-15A x K-13/1017, and DHLB-15A x K-13/995. These crosses involved either average x average, good x poor, poor x poor or good x average general combining parents. These crosses have been identified as best hybrids for improving grain yield per plant and could be further evaluated to confirm their stable superior performance.

Key words: *Pearl millet, Combining ability, Gene action, Line x tester analysis*

INTRODUCTION

Pearl millet *(Pennisetum glaucum* (L.) R. Br.) is a commonly known as bajra, cat-tail millet, or bulrush millet in different parts of the world. It is a member of family Poaceae and has somatic chromosome number (2n) of 14. It is an important member of the genus *Pennisetum*, which has high importance for both food and fodder and it is the most drought tolerant cereal. The economic part of pearl millet is grain. However, Pearl millet is being grown in arid and semi-arid regions of the world including West Africa, India and Pakistan with the rainfall ranging from 150-700 mm. India is a major pearl millet producing country in the world with an area and production of 43.3 and 42 per cent respectively.

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The share of pearl millet among the production of total food grains is 10.7 %. In India, it is cultivated in an area of 9.43 million hectares with an annual production of 8.15 million tones and average productivity of 850 kg/ha[1]. It is widely cultivated in the states of Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana. Commercial hybrid seed in pearl millet is possible mainly through the development of hybrids by the utilization of cytoplasmic genetic male sterility system. Burton[5] was the first to develop cytoplasmic male sterile line, Tift 23A. This opened up a new field for hybrid seed production in pearl millet. The use of CMS in pearl millet paved the way for grain yield augmentation with the development and release of the high yielding hybrids. An understanding of the combining ability and gene action is a pre-requisite for any successful plant breeding programme. 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. The present experiment was, therefore planned to Assessment of Combining Ability in Pearl Millet Using Line x Tester Analysis

MATERIAL AND METHODS

The present study on pearl millet was conducted at Department of Genetics and Plant Breeding, College of Agriculture, Dhule, under Mahatma Phule Krishi Vidyapith, Rahuri Maharashtra. Four diverse male sterile lines (cytoplasm A1) *viz.*, RHRB-15A, DHLB-16A, DHLB-17A, DHLB-18A were crossed with twelve testers *viz.*, K-13/973, K-13/991, K-13/995, K-13/996, K-13/999, K-13/1005, K-13/1007, K-13/1008, K-13/1009, K-13/1011, K-13/1016 and K-13/1017, in a line x tester mating design during *Summer* 2014 to produce 48 hybrids. The resulted 48 hybrids along with 16 parents were evaluated during *Kharif* 2014 in a Randomized Block Design with two replications. Each plot with a spacing of 50 x 15 cm consisted of two row 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 replication and entry for 12 traits *viz.*, days to 50% flowering, days to maturity, plant height (cm), ear head girth (cm), ear head length (cm), number of productive tillers per plant, number of grain per sq. cm, 1000-grain weight (g), fodder yield per plant (g), grain yield per plant (g), grain Fe content (mg/kg) and grain Zn content (mg/kg). The mean values were used for the analysis of variance for experimental design. Combining ability analysis was computed using line x tester procedure developed by Kempthorne[7] modified by Arunachalam[3].

RESULTS AND DISCUSSION

The results of analysis of variance for combining ability indicated that the mean squares due to lines were found to be highly significant for days to 50 % flowering, days to maturity, earhead girth, number of grain per sq. cm, grain Zn content (mg/kg). In case of testers significant values were obtained for all the characters except for grain Fe content (mg/kg), whereas the mean squares due to line x tester were found highly significant for all the characters except for number of productive tillers per plant under study (Table 1).

Estimates of general combining ability effects: The estimates of general combining ability (GCA) effects of parent for all the characters have been given in Table 2. General combining ability effects suggested that K-13/991, K-13/999, K-13/1005 and DHLB-18 A were found to be the best general combiners for yield and some of its attributes. K-13/999 showed maximum GCA effects for grain yield per plant, fodder yield per plant, number of productive tillers per plant, earhead length, 1000 grain weight, grain Fe content (mg/kg) and grain Zn content (mg/kg) hence was considered most desirable. K-13/991 was found to be good general combines for grain yield per plant, number of productive tillers per plant, plant height, earhead length and fodder yield per plant while K-13/1005 proved to be good general combiner for grain yield per plant, number of productive tillers per plant, plant height, fodder yield per plant. Similarly, DHLB-18 A was identified as good general combiner for grain yield per plant, grain Fe content (mg/kg), grain Zn content (mg/kg).

Estimates of specific combining ability effects: The best specific combination was observed in four cross for grain yield per plant. The best specific combination *viz.*, DHLB-17A x K-13/1005 (average x good), followed by DHLB-16A x K-13/1008, (average x poor), DHLB-15A x K-13/1017 (poor x good), DHLB-15A x K-13/995 (poor x poor) combining parents (Table 3). The relationship between GCA and SCA effects revealed that significant and desirable SCA effects can occur in any group of parents. This indicate presence of higher order interaction in the expression of these traits and in all depends upon how well genes from two parent interact. The good general combiners when crossed may not always produce the best hybrid. Marked negative effects in crosses between good x good were noteworthy, which could be attributed to the lack of complementation between favourable alleles of the parents involved. Marked positive SCA effects in crosses between good x poor and poor x poor could be ascribed to better complementation between favourable alleles of parents involved. These findings are in agreement with the earlier findings of Pethani *et al.*[11], Bhanderi *et al.*[4], Vagadiya *et al.*[13], Lakshmana *et al.*[8], Parmar *et al.*[10], and Mungra *et al*[9].

Table No. 1. Analysis of variance for combining ability

Source of Variations	d.f.	Days to 50 % flowering	Days to maturity	Plant height (cm)	No. of effective tillers /plant	Ear head length (cm)	Ear head girth (cm)	Grain yield /plant (g)	Fodder yield /plant(g)	1000 grain weight (g)	No. of grains /cm^2	Fe conten (mg/kg)	Zn content (mg/kg)
		1	2	3	4	5	6	7	8	9	10	11	12
Replications	1	2.66	0.042	149.00 *	0.083	3.80	0.173	18.113	60.341	1.73	0.173	1.260	15.84
Crosses	47	6.38**	6.69 **	280.06**	0.25 **	10.39**	10.95**	174.55*	582.94**	3.18 **	10.95**	123.15**	50.57**
Females	3	23.62**	19.19**	69.38	0.04	2.47	30.89*	128.41	69.90	0.28	30.89*	244.28	230.28**
Males	11	13.019**	13.82**	623.33**	0.68**	29.76**	16.18 *	442.0**	1544.13**	5.75 *	16.18*	134.10	101.42**
Female x Males	33	2.60 **	3.18 **	184.79**	0.13	4.65**	7.40 *	89.58 **	309.18**	2.59**	7.40 *	108.50**	17.28**
Error	47	0.645	0.957	35.002	0.085	0.965	3.709	22.867	59.472	0.470	3.709	6.665	5.503

Table No. 2 (a). The Estimates of General Combining ability effect for different characters in pearl millet

S. No	Parents	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of effective tillers / plant	Ear head length (cm)	Ear head girth (cm)	Grain yield /Plant (g)	Fodder yield /plant (g)	1000 grain weight (g)	No. of grain /cm^2	Fe content	Zn Content
1.	DHLB-15A	-1.18**	-1.25**	0.59	0.04	-0.42 *	-0.14	-2.64**	-0.81	0.01	-0.96*	-2.51**	-0.65**
2.	DHLB-16A	-0.43*	-0.04	-2.36	0.02	0.04	-0.29**	-1.18	-1.17	0.11	1.64**	2.17**	-3.94**
3.	DHLB-17A	0.93**	0.62**	1.65	-0.04	0.36	0.45**	1.50	-0.54	-0.14	-0.26	0.28	1.26*
4.	DHLB-18A	0.68**	0.66**	0.11	-0.03	0.00	-0.018	2.32*	2.53	0.00	-0.41	4.40**	3.34**
SE+		0.23	0.28	1.71	0.08	0.28	0.15	1.38	2.23	0.20	0.56	0.75	0.68
CD at 5 %		0.46	0.56	3.44	0.17	0.57	0.30	2.78	4.48	0.40	1.12	1.50	1.36
CD at 1 %		0.62	0.76	4.58	0.23	0.76	0.40	3.71	5.98	0.53	1.49	2.00	1.82

Table No. 2 (b). The Estimates of General Combining ability effect for different characters in pearl millet

S. No	Parents	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of effective tillers / plant	Ear head length (cm)	Ear head girth (cm)	Grain yield /Plant (g)	Fodder yield /plant (g)	1000 grain weight (g)	No. of grain /cm^2	Fe content	Zn Content
1	K-13/973	-2.39**	-2.29**	8.32**	-0.22*	-0.59	0.57 **	-5.70**	-9.13**	-1.10**	0.04	2.49	-1.32**
2	K-13/991	1.35**	1.70**	-10.7**	0.30**	-0.49	-0.28	8.62**	14.70**	0.08	0.64	-4.76**	-5.07**
3	K-13/995	0.72*	0.70*	1.71	-0.22*	0.15	0.19	-5.58**	-10.3**	0.57**	0.96	-3.76**	-0.57**
4	K-13/996	1.85**	1.58**	13.64**	-0.01	-0.54	0.79**	-1.15	-0.93	0.63**	0.54	1.11	3.17
5	K-13/999	-0.14	-0.54	13.55**	0.35**	2.03**	-0.03	12.30**	14.46**	0.74**	-1.62*	5.74*	6.92**
6	K-13/1005	0.60*	1.08**	-9.22**	0.38**	0.53	0.07	7.44**	22.79**	0.02	-3.15**	-4.76**	-6.07**
7	K-13/1007	1.47**	1.33**	-8.29**	0.19	-2.54**	-0.18	4.44*	7.38**	-0.25**	-0.19	0.49	0.92
8	K-13/1008	-1.27**	-1.41**	5.05*	-0.35**	0.88*	0.145	-8.20**	-15.5**	0.93**	0.44	-2.51**	3.17
9	K-13/1009	-1.27**	-1.29**	-10.67**	-0.21*	4.08**	0.27	-5.80**	-11.92**	1.12**	-1.14	-2.51**	-2.19**
10	K-13/1011	0.10	0.33	-0.14	-0.47**	0.97**	-0.79 **	-11.03**	-22.13**	-0.77**	2.36**	-1.26**	0.17
11	K-13/1016	-0.52	-0.41	-1.34	0.19	-2.7**	-0.48*	0.29	6.06*	-0.42**	0.19	1.49	0.92
12	K-13/1017	-0.52	-0.79*	-1.82	0.07	-1.7**	-0.28	4.37*	4.618	-1.55**	0.91	8.24 **	-0.07**
SE+		0.40	0.49	2.96	0.15	0.49	0.26	2.39	3.86	0.34	0.96	1.29	1.17
CD at 5 %		0.80	0.98	5.95	0.29	0.99	0.51	4.81	7.76	0.69	1.94	2.60	2.36
CD at 1 %		1.07	1.31	7.94	0.39	1.32	0.69	6.42	10.35	0.92	2.59	3.47	3.15

Table No. 3 (a). The Estimates of Specific Combining ability effect for different characters in pearl millet

Sr. No	Parents	Days to 50% flow-ering	Days to maturity	Plant height (cm)	No. of effect-ive tillers /plant	Ear head length (cm)	Ear head girth (cm)	Grain yield /Plant (g)	Fodder yield /plant (g)	1000 grain weight (g)	No. of grain /cm^2	Fe content	Zn content
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	DHLB15A x K-13/973	0.31	0.25	5.83	0.09	1.67 *	-0.30	3.90	4.25	0.13	-0.12	12.01**	-1.59
2	X K-13/991	-0.94	-1.25	9.95*	-0.19	0.77	0.16	-6.43	-9.69	0.55	1.33	-2.74	0.15
3	X K-13/995	-1.31*	-0.75	-7.35	0.29	-1.88**	-0.07	8.07 *	9.52	-0.64	1.91	-4.74 *	3.65*
4	X K-13/996	0.06	0.38	-16.08**	-0.54 *	-0.38	0.08	-10.05**	-24.75**	-0.21	-0.24	3.39	2.91
5	X K-13/999	-0.44	-0.50	20.10**	0.09	-0.46	0.21	2.75	2.40	-0.02	-0.66	5.76 **	-3.84*
6	X K-13/1005	-0.19	-1.13	11.37*	-0.09	0.25	0.41	-7.71*	-10.92	0.21	2.07	1.26	-1.84
7	X K-13/1007	0.94	0.13	-0.85	-0.17	0.42	-0.05	-3.55	-9.11	0.28	0.34	5.010*	-2.84
8	X K-13/1008	0.19	0.88	5.30	-0.08	-2.60**	-0.02	1.20	-0.38	0.20	1.86	-7.99**	-3.09
9	X K-13/1009	1.68**	1.25	-16.4**	0.18	1.00	-0.30	6.30	5.49	-3.4**	-1.26	-1.99	-1.71
10	X K-13/1011	-0.69	-0.38	-12.59**	0.03	0.36	0.07	3.62	3.20	1.50 **	-0.77	-6.24**	0.91
11	X K-13/1016	-0.06	0.38	0.50	0.09	-1.93**	-0.05	-7.703 *	7.30	-0.34	-2.41	3.01	5.15**
12	X K13/1017	0.44	0.75	0.28	0.29	2.79 **	-0.15	9.622**	22.69**	1.73 **	-2.05	-6.74**	2.16
	SE+	0.80	0.98	5.92	0.29	0.98	0.51	4.78	7.71	0.69	1.93	2.58	1.66
	CD at 5 %	1.62	1.97	11.90	0.59	1.98	1.03	9.62	15.51	1.38	3.87	5.19	3.34
	CD at 1 %	2.16	2.63	15.88	0.78	2.64	1.37	12.84	20.70	1.84	5.17	6.93	4.45

Table No. 3 (b). The Estimates of Specific Combining ability effect for different characters in pearl millet

Sr. No	Parents	Days to 50% flow-ering	Days to maturity	Plant height (cm)	No. of effect-ive tillers /plant	Ear head length (cm)	Ear head girth (cm)	Grain yield /Plant (g)	Fodder yield /plant (g)	1000 grain weight (g)	No. of grain /cm^2	Fe content	Zn content
1	2	3	4	5	6	7	8	9	10	11	12	13	14
13	DHLB16A X K13/973	1.06	1.54 *	-8.11	-0.11	0.33	0.41	-1.57	-5.18	-0.47	-0.86	-16.3**	-0.30
14	X K-13/991	0.31	1.04	-7.89	0.01	1.73 *	0.21	-1.20	-3.12	-0.46	-0.56	0.93	0.45
15	X K-13/995	-0.56	-0.45	-0.60	-0.43 *	0.68	-0.57	-7.895 *	-14.45*	-0.94	-1.52	-1.07	-2.05
16	X K-13/996	-0.18	0.17	6.58	0.17	-0.92	-0.02	4.28	9.62	-1.20*	-0.76	-4.94*	0.20
17	X K-13/999	-0.68	-1.20	-3.34	-0.02	0.01	0.01	-1.52	-1.58	0.58	-0.26	3.43	3.44 *
18	X K-13/1005	-2.43**	-2.33**	-8.66	-0.20	-0.093	-0.491	-8.68 *	-16.05**	0.60	1.142	-0.07	-0.55
19	X K-13/1007	1.18 *	1.91**	3.41	-0.037	-2.91**	0.059	-2.02	-0.94	-0.61	-0.03	1.67	1.44
20	X K-13/1008	1.43*	1.167	10.56*	0.464 *	1.35	-0.116	9.93**	18.89**	-0.005	1.042	8.67**	5.19**
21	X K-13/1009	-1.063	-1.45*	-2.212	-0.028	0.157	-0.441	1.030	0.453	2.00**	-0.41	9.67**	1.073
22	X K-13/1011	0.56	0.42	10.363 *	-0.11	-0.93	0.12	-1.05	0.32	-1.09*	1.76	-5.57**	-0.80
23	X K-13/1016	1.18*	0.67	-0.04	-0.03	0.63	0.36	4.83	0.67	1.55**	1.11	-2.32	-7.55**
24	X K-13/1017	-0.81	-1.45*	-0.06	0.32	-0.04	0.46	3.86	11.41*	0.03	-0.64	5.92**	-0.55
	SE+	0.80	0.98	5.92	0.29	0.98	0.51	4.78	7.71	0.69	1.93	2.58	1.66
	CD at 5 %	1.62	1.97	11.90	0.59	1.98	1.03	9.62	15.51	1.38	3.87	5.19	3.34
	CD at 1 %	2.16	2.63	15.88	0.78	2.64	1.37	12.84	20.70	1.84	5.17	6.93	4.45

Table No. 3 (c). The Estimates of Specific Combining ability effect for different characters in pearl millet

S. No	Parents	Days to 50% flow-ering	Days to maturity	Plant height (cm)	No. of effect-ive tillers /plant	Ear head length (cm)	Ear head girth (cm)	Grain yield /Plant (g)	Fodder yield /plant (g)	1000 grain weight (g)	No. of grain /cm^2	Fe content	Zn content
1	2	3	4	5	6	7	8	9	10	11	12	13	14
25	DHLB17AK-13/973	-0.31	0.37	7.78	-0.22	-2.29**	-0.10	-7.45*	-9.17	0.49	0.05	-1.78	-0.51
26	X K-13/991	0.93	-0.62	7.20	0.09	-1.29	-0.10	2.61	6.19	-0.09	-2.45	3.46	-3.76*
27	X K-13/995	0.56	0.38	4.94	0.02	0.16	-0.17	-1.98	-0.55	0.02	-0.05	12.46**	0.74
28	X K-13/996	-0.06	0.00	8.16	0.19	1.26	-0.12	3.19	8.93	0.06	-1.57	7.09**	-2.01
29	X K-13/999	-0.56	-0.38	-17.15**	0.06	0.18	-0.15	-1.21	-2.57	0.35	-0.67	-0.03	1.24
30	X K-13/1005	1.18*	1.50*	-7.28	-0.03	-0.62	0.36	11.23**	9.80	-0.23	-1.37	-8.53**	2.24
31	X K-13/1007	-1.68**	-1.25	-4.40	0.17	1.26	0.16	2.79	5.62	0.14	-1.78	-5.78**	2.24
32	X K-13/1008	-1.43*	-1.50*	-10.85 *	-0.25	0.83	-0.07	-4.96	-9.80	-0.64	-1.17	4.219*	1.99
33	X K-13/1009	0.06	0.38	7.08	-0.32	-0.07	0.36	-8.957 *	-11.68*	0.22	0.22	-9.78**	0.37
34	X K-13/1011	1.18*	0.75	-0.95	0.30	-0.76	0.22	4.47	12.52 *	-0.43	2.33	4.969 *	-1.01
35	X K-13/1016	-0.69	-0.50	0.25	0.13	0.51	-0.30	2.24	0.78	0.52	3.99**	-3.78	0.24
36	X K-13/1017	0.81	0.88	5.23	-0.15	0.83	-0.10	-1.98	-10.07	-0.41	2.48	-2.53	-1.76
	SE+	0.80	0.98	5.92	0.29	0.98	0.51	4.78	7.71	0.69	1.93	2.58	1.66
	CD at 5 %	1.62	1.97	11.90	0.59	1.98	1.03	9.62	15.51	1.38	3.87	5.19	3.34
	CD at 1 %	2.16	2.63	15.88	0.78	2.64	1.37	12.84	20.70	1.84	5.17	6.93	4.45

Table No. 3 (d). The Estimates of Specific Combining ability effect for different characters in pearl millet

S. No	Parents	Days to 50% flow-ering	Days to maturity	Plant height (cm)	No. of effect-ive tillers /plant	Ear head length (cm)	Ear head girth (cm)	Grain yield /Plant (g)	Fodder yield /plant (g)	1000 grain weight (g)	No. of grain /cm²	Fe content	Zn content
1	2	3	4	5	6	7	8	9	10	11	12	13	14
37	DHLB18 AK-13/973	-1.06	-2.16**	-5.49	0.23	0.29	-0.02	5.13	10.11	-0.16	0.93	6.09**	2.40
38	X K-13/991	-0.31	0.83	-9.267 *	0.10	-1.21	-0.27	5.01	6.62	0.00	1.68	-1.66	3.16
39	X K-13/995	1.31*	0.83	3.02	0.12	1.04	0.805 *	1.81	5.48	1.56**	-0.35	-6.65**	-2.34
40	X K-13/996	0.19	-0.54	1.35	0.18	0.04	0.06	2.58	6.21	1.353 *	2.57	-5.53**	-1.09
41	X K-13/999	1.68**	2.08**	0.38	-0.13	0.27	-0.07	-0.02	1.76	-0.91	1.59	-9.15**	-0.84
42	X K-13/1005	1.43*	1.95**	4.56	0.32	0.47	-0.27	5.17	17.18**	-0.58	-1.83	7.34**	0.16
43	X K-13/1007	-0.44	-0.79	1.83	0.03	1.24	-0.17	2.78	4.45	0.19	1.48	-0.91	-0.84
44	X K-13/1008	-0.19	-0.54	-5.02	-0.14	0.42	0.21	-6.17	-8.72	0.45	-1.73	-4.90*	-4.09*
45	X K-13/1009	-0.69	-0.17	11.608*	0.17	-1.08	0.38	1.63	5.75	1.166*	1.46	2.09	0.28
46	X K-13/1011	-1.06	-0.79	3.18	-0.22	1.33	-0.41	-7.045 *	-16.04**	0.02	-3.32*	6.84**	0.91
47	X K-13/1016	-0.44	-0.54	-0.72	-0.19	0.79	-0.02	0.63	-8.74	-1.73**	-2.70	3.09	2.16
48	X K-13/1017	-0.44	-0.17	-5.44	-0.46*	-3.58**	-0.22	-11.4**	-24.04**	-1.35*	0.22	3.34	0.16
	SE+	0.80	0.98	5.92	0.29	0.98	0.51	4.78	7.71	0.69	1.93	2.58	1.66
	CD at 5 %	1.62	1.97	11.90	0.59	1.98	1.03	9.62	15.51	1.38	3.87	5.19	3.34
	CD at 1 %	2.16	2.63	15.88	0.78	2.64	1.37	12.84	20.70	1.84	5.17	6.93	4.45

Table No. 4. Estimate of GCA, SCA, additive and dominance variances, gene action and heritability for different characters in pearl millet

Variances	Days to 50% flow-ering	Days to maturity	Plant height (cm)	No. of effect-ive tillers /plant	Ear head length (cm)	Ear head girth (cm)	Grain yield / Plant (g)	Fodder yield /plant (g)	1000 grain weight (g)	No. of grain /cm²	Fe content (mg/kg)	Zn content (mg/kg)
GCA	0.98**	0.83**	10.09	0.02	0.71**	0.12	10.81*	31.34*	0.02	1.00*	5.04	9.28**
SCA	0.97**	1.11**	74.89**	0.01	1.84**	-0.01	41.19**	147.91**	1.062**	1.84*	50.91**	5.89**
σ^2A	1.96	1.66	20.19	0.02	1.43	0.24	21.62	62.69	0.05	2.01	10.08	18.57
σ^2D	0.97	1.11	74.89	0.02	1.84	-0.01	41.19	147.91	1.06	1.84	50.91	5.89
$\sigma^2A : \sigma^2D$	2.00	1.49	0.26	1.18	0.77	-24.76	0.52	0.42	0.04	1.09	0.19	3.15

CONCLUSION

From the present findings it can be concluded that for the characters like, days to maturity, plant height, earhead length, 1000-grain weight, fodder yield per plant, grain yield per plant, no. of grain per cm^2 and grain Fe content displayed higher *sca* effect than *gca* effect indicated that there was substantial role played by dominance gene action. Such characteres could be improve through heterosis breeding or through segregants in the segregating generations, which the breeder can handle through pedigree method for developing high yielding types in pearl millet. While for characters like, days to 50 % flowering, number of effective tiller per plant, ear head girth and grain Zn content, the *gca* effect was higher than *sca* effect so these was governed by additive gene action. The presence of additive effects would enhance the chances of making improvement through simple selection. The most of the crosses exhibiting high sca effect involved either good x poor, poor x poor or good x good general combiners, for majority of the characters studied. The results suggested the presence of additive x dominance, dominance x dominance and additive x additive type of gene interactions. When epistasis is present, the recurrent selection followed by pedigree or biparental mating or diallel selective mating systems may prove to be effective in improvement of grain yield and its attributes in pearl millet. These findings are in agreement with the earlier findings of Shelke and Chavan[12], Arulselvi *et al.*[2], Velu *et al.*[14], Yadav *et al.*[15], Govindraj *et al.*[6], Mungra *et al*[9].

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