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Combining ability analysis for yield and its components in pearlmillet *(Pennisetum glaucum* (L) R. Br.)

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Abstract : Combining ability analysis for yield and its component characters was undertaken with eight lines, twelve testers and 96 hybrids for Line x Tester analysis. The interaction of Line x Tester was highly significant for all the characters studied. Variances due to *sca* was greater than that of *gca* indicating the expression of non-additive gene action for the traits studied in the present investigation except for plant height. The line ICMA 89111 and the tester IPC 001054 were found to be good general combiners for most of the traits studied. Further, a study of the *sca* effects of three most heterotic crosses revealed the involvement of either one or both poor general combiners. The hybrids ICMA 89111 x IPC 001264, 732A x IPC 001264 and 81A x IPC 001054 were found to be good specific combiners for spike yield and grain yield per plant and 1000 seed weight.

Key words : Combining ability, Line x Tester mating design, General combining ability, Specific combining ability, Gene interaction.

Introduction

Pearlmillet *(Pennisetum glaucum (L.) R. Br.)* is an important coarse grain cereal of India and South Africa. Its importance as a source of food and feed would continue in marginal lands situated in low rainfall areas. Its performance is excellent under adverse agro-climatic conditions like poor soils, inadequate and poorly distributed rainfall and short growing season and so highly preferred by farmers of arid and semi arid regions. Though bajra hybrids are being developed by utilising different cytoplasmic sources and released for cultivation in India, the practical utility of these newly developed cytoplasmic male sterile sources depends on the combining ability and vigour expressed by the hybrids. Hence, the basic objective for any breeding programme is to select the parents with good combining ability to produce superior hybrids. The present study was undertaken to estimate the combining ability of parents and hybrids, nature and magnitude of gene action for yield and yield components in pearlmillet by adopting Line x Tester analysis (Kempthorne, 1957)

Materials and Methods

Experimental materials for the present study comprised of eight cytoplasmic male sterile lines (81 A, L111A, ICMA 89111, ICMA 95444, ICMA 95555 (Al), 81Am, 81Av (A4), 732A (unclassified) source of.cytoplasms and twelve testers (IPC 000336, IPC 000401, IPC 000402, IPC 001054, IPC 001264, IPC 001610, IPC 001612, IP 8166, IP 8638, IP 9164, IP 9846, IP 10937) which were early (85 days) and resistant (<18% incidence) to downy mildew disease caused by *Sclerospora graminicola.* The parental materials were received from ICRISAT, Hyderabad and the Millet Breeding Station, Tamil Nadu Agricultural University, Coimbatore. Crosses were effected in Line x Tester mating design during *Kharif* 98. Ninety six hybrids thus obtained were raised with two replications in a randomized block design. Each entry was raised in two rows of 3 m length with a spacing of 45 x 15 cm adopting with normal recommended package of practices. Observations were recorded in five randomly selected plants in an entry for plant height, days to fifty per cent flowering, number of tillers, number of productive tillers, spike length, spike thickness, spike yield per plant, grain yield per plant and 1000 seed weight. The data were then subjected to statistical analysis and the results are discussed here under.

Results and Discussion

Analysis of variance showed highly significant differences in lines for days to fifty per cent flowering, number of tillers, spike length and testers for plant height, days to fifty per cent flowering, spike yield and grain yield per plant. The Line x Tester interaction also showed the existence of variation among the hybrid population for those traits (Table 1).

Table 1. ANOVA for combining ability

Source	df	Mean Squares								
		Plant height	Days to 50% flowering	No.of tillers	No.of prod. tillers	Spike length	Spike thickness	Spike yield/ plant	Grain yield/ plant	1000 seed weight
Lines	7	723.74	274.82**	7.15**	1.38	161.91**	4.98	191.02	151.07	8.65
Testers	11	9162.82**	97.44**	2.48	0.89	17.88	3.36	1171.49**	725.30**	7.11
Line x Tester	77	421.36**	24.64**	2.45**	1.10**	12.68**	3.31	372.58**	266.77**	4.73**
Error	95	8.11	2.08	0.054	0.02	0.90	0.04	1.64	1.694	0.08
GCA		226.09	8.07	0.12	0.018	3.86	0.43	15.43	8.57	0.16
SCA		206.64	11.29	1.194	0.506	5.89	0.86	185.48	132.54	2.32

Table 2. Lines with high mean and significant *gca* effects

Character	ICMA 89111		732 A		ICMA 95444		L111A	
	Mean	*gca*	Mean	*gca*	Mean	*gca*	Mean	*gca*
Plant height (cm)	93.81	-5.29**	59.15	1.74*	94.99	-11.11	103.81	3.34**
Days to 50% flowering	48.00	-4.84**	52.50	4.16**	49.50	-5.46**	49.00	2.08**
No. of tillers	6.90	0.77**	8.10	0.66**	4.70	0.57*	5.00	-0.43**
No. of prod. tillers	4.70	0.33**	5.20	0.28**	3.30	0.16**	3.70	-0.07
Spike length (cm)	16.98	0.16	15.27	-1.47**	18.95	0.68*	23.06	6.04**
Spike thickness (cm)	4.87	-0.53**	5.17	-0.40**	4.29	0.59**	5.38	0.18**
Spike yield/plant (g)	28.41	3.15**	28.83	1.46**	28.24	-3.65**	30.88	-1.60**
Grain yield/plant (g)	25.76	3.50**	21.31	-0.81*	20.01	-2.72**	22.08	-0.31
1000 seed weight (g)	10.25	0.42**	10.23	0.17*	10.22	0.33**	10.31	0.64**

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

Table 3. Testers with high mean and significant *gca* effects

Character	IPC 000401		IPC 001054		IPC 001610	
	Mean	gca	Mean	gca	Mean	gca
Plant height (cm)	113.63	-24.40	152.65	26.14	111.94	9.74
Days to 50% flowering	51.50	-3.01**	48.50	2.24**	51.50	-3.13**
No. of tillers	6.10	0.17*	5.00	0.05	5.70	0.52**
No. of prod. tillers	4.40	0.37**	3.50	-0.08	3.70	0.29**
Spike length (cm)	16.64	1.49**	20.23	1.31**	17.12	-0.74*
Spike thickness (cm)	5.20	0.85**	8.35	0.75**	6.50	0.05
Spike yield/plant (g)	30.06	-2.29**	31.14	17.12**	30.88	5.33**
Grain yield/plant (g)	19.94	-3.49**	23.55	12.47**	22.55	5.66**
1000 seed weight (g)	10.39	0.80**	10.30	0.91**	10.32	0.13

Table 4. Crosses with high mean and significant *sca* effects

Character	ICMA89111 X IPC 601264		ICMA 7324 x IPC 001264		ICMA 81A x IPC 001054	
	Mean	*sca*	Mean	*sca*	Mean	*sca*
Plant height (cm)	154.83	2.11	195.64	18.04	198.30	17.99**
Days to 50% flowering	42.00	-1.41	56.50	0.65	50.50	-0.99
No. of tillers	8.0	0.15	6.3	0.34*	5.4	-1.36**
No. of prod. tillers	4.4	0.46*	3.9	0.26*	2.1	-1.53**
Spike length (cm)	18.69	0.61	20.63	0.70	24.92	4.07**
Spike thickness (cm)	8.70	0.84**	8.24	0.79**	7.80	-0.81**
Spike yield/plant (g)	96.35	33.22**	95.06	24.15**	94.11	19.01**
Grain yield/plant (g)	74.55	25.01**	73.86	21.79**	76.94	20.99**
1000 seed weight (g)	12.68	1.65**	13.05	2.78**	11.54	0.72*

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

The predominance of variance due to *sca* over *gca* showed that non-additive type of gene action was involved for the control of traits *viz.* days to fifty per cent flowering, number of tillers and productive tillers, spike length, spike thickness, spike and grain yield per plant. The findings are in conformity with the results reported earlier for days to fifty per cent flowering (Balakrishnan and Vijendra Das, 1996), number of tillers (Basavaraju *et al.* 1980), spike yield per plant (Azhaguvel 1997) and 1000 seed weight (Kulkarni *et al.* 1993) except for plant height (Dandeba *et al.* 1993).

The study of *gca* effects (Table 2) revealed ICMA 89111 to be a good general combiner for number of tillers (0.77) and productive tillers (0.33), spike yield (3.16), grain yield (0.50) per plant and 1000 seed weight (0.42). Further, the line L 111A showed highly significant and positive *gca* effects for plant height (3.34), spike length (6.04) and 1000 seed weight (0.64). The lines ICMA 89111 and ICMA 95444 were found to be early in flowering with highly significant and negative *gca* effect. These cytoplasmic male sterile lines (ICMA 89111 and ICMA 95444) are the good parents for producing short duration pearlmillet hybrids suited for rainfed areas, so as to utilize the available moisture in short period, to yield more.

The testers IPC 001054 expressed highly significant and positive *gca* effects for days to fifty per cent flowering (2.24), spike length (1.31), spike thickness (0.75), spike yield per plant (17.12), grain yield per plant (12.47) and 1000 seed weight (0.91), but significant and negative *gca* effects for days to fifty per cent flowering was observed in IPC 000401, IPC 001610. The tester IPC 001610 showed highly significant positive *gca* effects for spike yield per plant (5.33) and grain yield per plant (5.66) (Table 3).

The results on *sca* effects (Table 4) revealed that the hybrids ICMA 89111 x IPC 001264 and 732A x IPC 001264 expressed highly significant and positive *sca* effects for number of productive tillers, spike thickness, spike yield per plant, grain yield per plant and 1000 seed weight. The *sca* effects of three most heterotic crosses for yield and its component characters indicated that these specific cross combinations involved either one or both low *gca* parents. The possibility of obtaining such superior crosses with high *sca* effects from the combination of parents with low *gca* effects was reported earlier (Nawar *et al.* 1979). Among these, ICMA 89111 x IPC 001264 and 732A x IPC 001264 were good specific combiners and expressed additive x dominance gene action for most of the traits studied. Hence, advance generations of these crosses may be grown in isolation for getting desirable transgressive segregants.

From this study, it can be interpreted that the hybrid ICMA 89111 x IPC 001264 can be improved by hybrid breeding programme since it expressed non additive gene action for most of the traits studied, or can be used for population improvement through reciprocal recurrent selection because of its earliness, more number of tillers, productive tillers, spike thickness, spike yield per plant, grain yield per plant, 1000 seed weight.

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