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Studies on Combining Ability in Pearl Millet *(Pennisetum americanum* (L) K Schum)

P. JANARDHANA RAO[1] and V. REDDI[2]

Combining ability of ten inbred lines of pearl millet of African and Indian origin were studied through diallel crossing technique for yield and yield attributes viz., plant height, days to flower,ear number, ear length, ear girth,ear packing and 1000-grain weight. Both additive and non-additive types of gene action were found to play a significant role in bringing out the heterotic effects in these characters. The *g.c.a.* effects of the parents and the *s.c.a.* effects of the crosses showed that none of the parents were useful for simultaneous improvement of all the characters as they were found to be good for a single or a few characters only. Selection indices were worked out to evaluate the genotypic value of the cross. They confirmed the superiority of the parents Sereri A, RP. 118/3-5 and RP. 156/2 in enhancing the genotypic value of the hybrids for most of the characters.

Information on combining ability of yield and yield attributes helps the breeder in choosing the right type of parents for developing hybrids, synthetics and composites. Several workers have reported combining ability studies in pearl millet (*Pennisetum americanum* L) K. schum (Hirachand *et.al.*, 1973; and Tewari 1974). In the present paper the results of the study on combining ability of ten pearl millet inbred lines of African and Indian origin for eight important yield attributes including yield are reported)

MATERIAL AND METHODS

Ten inbreds *viz.*, J. 1244 (P_1), J. 1623 (P_2), J, 1644 (P_3) (Jamnagar. Gujarat), 700561 (P_4), Sereri A (P_5), (African), RP. 25/4-3 (P_6), RP. 79/5-1 (P_7), RP. 87/1-1 (P_8), RP. 118/3-5 (P_9) and RP. 156/2 (P_{10}) (Rajendranagar, Andhra Pradesh) were crossed in all possible combinations (excluding reciprocals) during summer 1976. The parents and their 45 cross combinations (F_1's) were grown in randomised complete block design with three replications during kharif 1976 at Agricultural Research Institute, Rajendranagar, Hyderabad, A. P. Each entry was sown in a single row of 3.75 m long. Row to row spacing was 45 cm and hill to hill 15 cm. At maturity 5 plants from each row were randomly chosen for recording data on plant height, days to flower, ear number, ear length, ear girth, ear packing, 1000-grain weight and grain yield General and specific combining

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1. Asst Millet Specialist, Agricultural Research Station, Madhira.

2. Principal and Head Dept. of Plant Breeding and Genetics, Agricultural College Bapatla-502101

abilities were calculated according to Method II, model I of Griffing (1956). Selection indices were computed as per Patel *et.al.*, (1969).

RESULTS AND DISCUSSION

The results of analysis of variance showed that mean squares due to genotypes were significant for all the characters indicating the existence of genetic variability in the material selected for study.

The ANOVA for combining ability (Table-1) revealed that the mean squares for *g. c. a.* as well as *s. c. a.* were significant for all the characters. The variance components for the *s. c. a.* were higher than their respective *g. c. a.* components. This suggests that both additive and non-additive genetic components play a significant role in the expression of these characters.

The *g. c. a.* effects (Table-2) showed that parent 5 was a good combiner for three attributes viz., grain yield, 1000-grain weight, ear girth and moderately a good combiner for earliness and parent 3 for ear number as well as for dwarf stature and early maturity. Parent 10 also was a good combiner for early flowering, dwarf stature in addition to ear packing. Parent 2 was a good combiner for ear length. Parents 1, 4 and 9 were medium to good combiners for most of the ear characters.

The estimates of *s. c. a.* effects (Table-3). revealed that the cross between parents 1X5 was best for dwarfness. P 10 also appeared to be good for inducing dwarfness as seen by the crosses 9X10 and 7X10. Apart from these two crosses, the parent 10 has also induced dwarfness in three more cross combinations (data not furnished in the table). Parents 5 and 4 seemed to be good combiners (5 x 7, 4 x 6 and 2 x 4) in inducing early flowering. No definite trend was observed for ear number and ear length, to show the preponderance of any parent. However, for ear girth, the top two hybrids 2 x 5 and 5 x 6, had P_5 as one of the parentes. For ear-packing, parent 6 was involved in all the best three hybrids i. e. 6 x 8, 5 x 6 and 6 x 7. In respect of grain yield P_2 was a common parent for the best two crosses (2 x 8, and 2 x 9), though 5 x 10 occupies the first rank. This may be due to the highest *g.c.a.* effects of atleast one of the parents for their character.

Each of the parents did well for a particular or a few attributes only. As such it would be difficult to study the progeny of several possible cross combinations of these parents. Hence, to evaluate the genotypic value of the cross selection index was calculated based on the *s.c.a.* and *g.c.a.* effects of the parents involved, using their variances as weights in each of the hybrids.

The indices (Table-3) showed that the best three hybrids for all the characters, generally involved parents 5' 9 and 10. The influence of parent 5 was seen in best crosses for grain yield (5 x 10 and 5 x 9) , 1000-grain weight (2 x 5 and 1 x 5) and ear length (2 x 5, 5 x 6 and 5 x 8) in addition to early

maturity (3 x 5, 5 x 10 and 5 x 6). Parent 9 was involved in the best hybrid for grain yield and also to induce dwarfness (9 x 10). Similarly the effect of parent 10 was evident in the best crosses for grain yield (5 x 10), ear packing (9 x 10 and 3 x 10), early maturity (5 x 10), and dwarf plant types (9 x 10 and 7 x 10).

With regard to the *g. c. a.* and *s. c. a.* effects of the parents the parents 5 with the high positive *g.c.a* effects could influence the expression of the crosses 5X10 and 5X9 for high grain yield, 2X5 and 1X5 for 1000-grain weight and 2X5, 5X6 and 5X8 for ear length. The high negative *g. c. a.* of parent 5 lowered the duration in combinatons of 3X5, 5X10 and 5X6. The parent 1 with its hig-negative *g. c. a.* reduced the height of the plant in the cross 1X5. The parent 9 with its high *g. c. a.* could increase grain yield in the cross 2X9, ear packing in the cross 9X10, ear number in the crosses 1X9 and 3X9. In the cross 4X9, the increased ear girth might be due the high *g. c. a.* of the parent 4. The dwarf stature of the cross 9X10 was due to the *g.c.a.* of the parent 10 rather than the *g.c.a.* of the parent 9. The high grain yield of 5X10, dense ear packing of 9X10 and 3X10, dwarf stature of 9X10 and 7X10 and early duration of 5X10, crosses could be attributed to the *g. c. a.* of the parent 10. Thus the selection indices show that the genotypic value is influenced by the *g.c.a.* of the parents. The diversity of geographic origin of parents would seen to lead to genetic diversity which in turn plays a significant role in influencing the genotypic values of crosses. For instance parent 5 (Sereri A) and parent 4 (700651) of African origin in combination with Indian parents 10, 2, 3and1, produced productive hybrids for majority of the characters like grain yield (5X10), 1000-grain weight (2X5), ear girth (2X4), ear length (2X5), early maturity (3X5) and dwarf stature (1X5).

These studies would further indicate that the hybrids involving parents Sereri A, RP 118/3-5 and RP-156/2 can be used with advantage in multiple crossing programme which may lead to the development of superior populations.

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TABLE-1 : Combining ability analysis for yield and yield components in pearl millet

	D. F.	Mean squares							
		Plant height	Days to flower	Ear number	Ear length	Ear girth	Ear packing	1000-grain weight	Grain yield
g. c. a.	9	1385.54**	28.84**	2.04**	26.35**	0.38**	55.41**	13.54**	165.15**
s. c. a.	45	336.77**	7.12**	1.27**	3.53**	0.02**	3.71**	1.17**	107.57**
Error	108	0.73**	0.002	0.005	0.018	0.0001	0.02	0.00:	0.45
g. c. a. variance		1038.71	21.63	1.52	19.75	0.28	41.54	10.15	123.54
s. c. a. variance		15136.89	320.53	57.16	158.21	0.82	166.19	52.36	4825.17
g. c. a./s. c. a.		0.069	0.068	0.027	0.125	0.341	0.250	0.194	0.026

**Significant at 1 per cent level

TABLE-2 : General combining ability effects of the parents

Characters/ Parents	Plant height	Days to flower	Ear number	Ear length	Ear girth	Ear packing	1000-grain weight	Grain yield
J.1244 (P_1)	-5.8**	2.04**	0.51**	0.71**	0.08**	-5.06**	1.13**	-3.52**
J.1923 (P_2)	18.31**	1.95**	-0.61**	2.43**	0.21**	-0.98**	0.86**	-0.57*
J.1644 (P_3)	-13.43**	-1.48**	0.73**	-1.80**	-0.12**	0.31**	-0.25**	-0.05
700651 (P_4)	14.83	0.97**	-0.29**	2.14**	0.04**	0.16**	0.37**	3.41**
Sereri A (P_5)	3.06**	-1.63**	-0.10**	-1.41**	0.34**	-0.67**	1.96**	7.45**
RP 25/4-3 (P_6)	-6.73**	-1.70**	-0.02	-0.37**	-0.07**	0.50**	-0.71**	-2.31**
RP 79/5-1 (P_7)	-5.94**	0.22	-0.18**	-0.08	-0.15**	0.03	-0.48**	-4.30**
RP 87/1-1 (P_8)	6.97**	0.84**	-0.39**	0.55**	0.03**	0.51**	-0.43**	0.33
RP 11/83-5 (P_9)	0.2	0.73**	0.27**	-0.50	-0.17**	2.23**	-0.92**	2.95**
RP 56/2 (P_{10})	-11.47**	-1.92**	-0.08*	-1.68**	-0.21**	3.00**	-1.52**	-3.38**

**Significant at 1 per cent level

*Significant at 5 per cent level

Table 3. Mean values for ten characters of best three F_1 hybrids of pearl millet computed as per s.c.a. effects and selection indices

Characters	Rank	*s. c. a. effects*		*selection indices*	
		Cross	Mean value	Cross	Mean value
Plant height	1	1 x 5	82.60	1 x 5	82.60
	2	9 x 10	13.53	9 x 10	113.53
	3	7 x 10	114.13	7 x 10	114.13
Days to flower (No.)	1	5 x 7	42.60	3 x 5	41.67
	2	4 x 6	43.47	5 x 10	42.00
	3	2 x 4	47.20	5 x 6	42.20
Ear number (No.)	1	2 x 6	5.80	3 x 9	7.33
	2	4 x 10	6.13	1 x 6	6.67
	3	3 x 9	7.33	1 x 9	6.40
Ear length (cm)	1	4 x 9	27.60	2 x 5	20.00
	2	2 x 3	26.47	5 x 6	19.87
	3	5 x 10	22.07	5 x 8	23.47
Ear girth (cm)	1	2 x 5	2.98	2 x 4	2.40
	2	5 x 6	2.70	4 x 9	27.60
	3	3 x 7	2.11	4 x 8	27.60
Ear packing No/cm²	1	6 x 8	21.00	6 x 8	21.00
	2	6 x 6	19.58	9 x 10	20.53
	3	6 x 7	18.90	3 x 10	20.29
1000-grain weight (gm)	1	1 x 3	11.57	2 x 5	12.09
	2	1 x 6	10.53	1 x 4	11.32
	3	1 x 9	10.22	1 x 5	8.00
Grain yield (gm)	1	5 x 10	66.60	5 x 10	66.60
	2	2 x 8	60.32	2 x 9	62.47
	3	2 x 9	62.47	5 x 9	60.79