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STUDIES ON COMBINING ABILITY IN PEARL MILLET (*PENNISETUM TYPHOIDES* (B.) S. AND H.)

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Combining ability estimates were obtained from a line x tester analysis of crosses involving six diverse male sterile line (female) with ten elite (male) genotypes [Non-additive type of gene action was found predominant for all the characters, except 500 grain weight where additive type of gene action was noticed. Among female parents M.S. 5141 A and M.S. 5054 A were top general combiners for grain yield and most of the other characters. H 271, H 686, H 54-3 and H 130-3 were the top ranking general combiners for grain yield and many of the other desirable attributes. The top cross combinations for grain yield were M.S. 2302A X H 54-3. JakhranaXH 54-3 and M.S. 111A X H 686. In general there was no correspondence between mean performance and S.C A. effects of the crosses in the present material.

Pearl millet is an important food and fodder crop of India With the release of first commercial hybrid in 1965 there was a tremendous increase n total production of pearl millet. This increase was due to the first male sterile line Tift 23A, developed by Burton in 1958. This line has been extensively utilized for the development of a number of high yielding pearl millet hybrids in India. However, this male sterile line as twell as other male sterile lines and heir hybrids have become highly susceptible to one or other diseases like downy mildew, smut and ergot. It has been observed that hybrid or a variety derived from narrow genetic base, usually breaks down in resistance to diseases quicker than the synthetic or composite population, which are developed from a broad and diverse genetic base. Under such circumstances where commercial seed production is a problem, the synthetic or composite population programme should be encoureged. Combining ability analysis is the best method to screen all the exotic and indigenous material. Compositing of superior male steriale lines and inbreds on g c.a. basis can be carried out to obtain superior populations through recurrent selection.

MATERIAL AND METHODS

Ten inbred lines developed from diverse sources were crossed with six male steriale lines namely M. S. 111A, M S. 5141A, M. S. 5054A, M. S. 23D2A, M. S 126 D2A, and an open pollinated variety Jakhrana. The 60 F_1 crosses along with four checks

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viz. PHB 14, BJ-104, NHB 5 and HB 3, were evaluated in a 8 x 8 simple lattice design with four replications at the Research Farm of Haryana Agricultural University, Hissar. Each entry was accommodated in single row plot of 3 m length. The row to row and plant to plant distance was kept as 50 cm and 15 cm respectively Data were recorded for grain yield (g/plot), ear weight (g/plot), effective tillers (no /plot), plant height, days to 50 per cent flowering and 500 grain weight (g). Analysis for combining ability was done by using the procedure developed by Kempthorne (1957).

RESULTS AND DISCUSSION

Analysis of variance for combining abillty and estimates of variance due to GCA and SCA are presenced in Table 1. The females were more variable than the males and hybrids for all the characters except days to 50 per cent flowering and 500 grain weight for which males exhibited high values. High variances for females observed in present investigation might be due to a wide diversity among the male sterile lines. It could also be due to the low number of the females lines (Gupta and Singh, 1967). The SCA variances were higher in magnitude than GCA for all the characters except 500 grain weight. The estimates of GCA and SCA variances revealed non-additive gene action for all the characters except 500 grain weight. The results of this study in pearl millet are comparable with those of earlier reports by (Nanda and Gupta, 1967, Murty *et al*, 1967, Parkash *et al*. 1977, Yadav *et al*. 1981, and Dass *et al*. 1982). Non-additive type of gene action was important for yield and yield components in this crop. General combining ability effects for females and males are presented in Table 2. Among females M. S. 1541A was the best combiner for grain yield and ear weight and good combiners for most of the other characters. M. S. 5054 A was the best general combiner for effective tillers and days to 50 per cent flowering and was the next best general combiner for grain yield and ear weight while it was the poorest combiner for the character 500 grain weight Jakhrana and M. S. 126 D$_2$A were the poorest combiner for grain yield and most of the other characters, but Jakhrana was the best general combiner for the grain yield, ear weight and 500 grain weight. H 686, H 64-3 and H 130-3 were the other top general combiners for most of the characters including grain yield. Of the 60 F_1's the five most superior crosses have been selected on the basis of *per se* expression and SCA effects are presented in Table 3. In general, there was no correspondence between these two parameters For grain yield in (M. S. 23D$_2$A x H-54-3) and effective tillers in (M. S. 5141A x H 54-3) however the cross combinations exhibited high values for both SCA and character expression. The other superior crosses for grain yield were Jakhrana x H 540-1, M. S. 111A x H 686. The best cross combination for effective tillers was M. S. 5141A x H 54-3 followed by Jakhrana x H 540-1 and M. S. 23 D$_2$A x H 271

For, 500 grain weight the highest SCA value was observed for M S. 23D,A x H 131 and the other top ranking crosses in this respect were Jakhrana x H 570-1 and M. S 5141A x H 686. The earliest flowering cross combination was M. S. 5054A x H 570 which exhibited the highest negative significant SCA value. Table 3 will reveal that mean performance of parents need not necessarily reflect their combining potential (Tyagi *et al.* 1975). Therefore, individual performance can not be taken as criterion for selection of parents. However, the parents with high GCA produced superior hybrids.

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TABLE 1 : Analysis of variance for combining ability.

		Grain weight (g)	Ear weight (g)	Effective tillers (nos.)	Plant height (cm)	500 grain weight (g)	50 per cent flowering (days)
Males	9	47701.08**	72854.31**	385.60*	967.61**	0.760	37.64**
Females	5	52057.71**	110149.73**	490.85**	1450.71**	0.752**	20.31**
Females X Males	45	17936.86**	37602.50*	180.50*	317.53*	0.051*	7.29*
Error	177	13580.50	21215.72	120.55	187.97	0.035	4.07
GCA		998.20	1687.45	8.05	27.86	0.022	0.68
SCA		1089.09	4071.69	14.99	32.39	0.004	0.80
SCA/GCA		1.09	2.41	1.86	1.16	0.18	1.18

*Significant at P=0.05; **Significant at P=0.01

TABLE 2 ; Effects of general combining ability.

Females	Grain weight (g)	Ear weight (g)	Effective tillers (no.)	Plant height (cm)	500 grain weight (g)	50% flowering (days)
M.S. 5141A	51.97**	80.16**	0.60	—0.33	1.02**	—0.60**
M.S. 5054A	39.27**	79.18**	7.00**	—6.43**	—2 60**	—1.05**
M.S. 111A	25.37**	8 33	—0.30	8.32**	0 63**	0.45**
M.S. $23D_2A$	3.77	—47.82**	1 80**	—12.58**	—0 30**	—1.90**
M S. $126D_2A$	—39.03**	—9.07	—3.60**	1·47**	0.19**	0.85**
Jakhrana	—81.33**	—11 32**	—4.90**	9.57**	1.06	1.35**
S.E. ±	4.37	5.46	0.41	0.51	0.007	0.075
Males						
H 570—1	—22.13**	34.35**	—0.90**	—0.43	—0.31**	1.56*
H 54 - 3	54.87**	57.26**	4.50**	—19.18**	1.37**	—1.68*
H 30—3	39 87**	81.85**	9.80**	—5.85**	0.43**	—2 60*
H-136—3	15.20**	—8 99**	0.60**	—4.18**	—0.18**	—0.77*
H 271	10.154**	110.18**	2.70**	5.15**	2.18**	0.35*
H 131	—82.46	—111.66**	—2.00**	—3 35**	—1.49**	—1.52**
H 172-3	—53.30**	—104 82**	—4.20**	3 74**	—0.73**	—0.10
H 540-1	—38.30**	—28.15**	—1.50**	5.65**	—0 55**	1.73**
H 686	58.87**	42.36**	0.30*	4.15**	—0.18**	0.56
H 570	74.13**	—72.32**	—8.80**	14.32**	—0.54**	3.15**
S. E. ±	2.42	3.03	0.22	0.28	0.003	0.42

* Significant at P = 0.005; ** Significant at P = 0.01

Table 3 : Five top crosses selected on the bais of *per se* performance and specific combining ability effects for various characters

Characters	Per se performance	SCA effects
Grain weight (g)	MS 23D$_2$ A X H 54-3 (894)	MS 23D$_2$A X H 54-3 (369.23)
	MS 111 A X H 696 (788)	Makhrana X H 540-1 (255.50)
	MS 111 A X H 136-3 (712)	MS 111 A X H 686 (237.63)
	MS 111 A X H 271 (710)	MS 111 A X H 130-3 (206.30)
	MS 5141 A X H 271 (690)	MS 23D$_2$A X H 570 (171.23)
Ear weight (g)	MS 5141 A X H 570-1 (1100)	MS 111 A X H 136-3 (387 83)
	MS 111 A X H 686 (1072.5)	MS 23D$_2$A X H 54-3 (368.23)
	MS 111 A X H 136-3 (1050.0)	MS 111 A X H 540-1 (359.08)
	MS 23D$_2$ A X H 54-3 (1040)	MS 5141 A X H 570-1 (323.14)
	MS 4054 A X H 570 (935)	Jakhrana X H 540-1 (277.14)
Effective tillers (No.)	MS 5141 A X H 54-3 (79)	MS 5141 A X H 54-3 (22.5)
	MS 5054 A X H 130-3 (74.5)	Jakhrana X H 540-1 (19.5)
	Jakhrana X H 540-1 (66)	MS 23D$_2$A X H 271 (16.1)
	MS 23D$_2$ A X H 540-1 (65 0)	MS 23D$_2$A X H 540-1 (14.6)
	MS 5141 A X H 130-3 (65.0)	MS 5054 A X H 172-3 (12.4)
Plant height (cm)	Jakhrana X H 686 (240)	MS 126D$_2$A X H 570 (24.78)
	MS 111 A X H 570 (238)	MS 5141 A X H 540-1 (23 00)
	Jakhrana X H 570 (237.5)	Jakhrana X H 686 (22.10)
	MS 5141 A X H 540-1 (232.5)	Jakhrana X 131 (17.25)
	MS 126D$_2$ A X H 570-1 (230)	MS 23D$_2$ A X H 570 (16.58)
500 grain weight (g)	MS 111 A X H 271 (3.65)	MS 23D$_2$ A X H 131 (0.225)
	MS 5141 A X H 271 (3.58)	Jakhrana X H 570-1 (0.186)
	MS 126D$_2$ A X H 271 (3.50)	MS 5141 A X H 686 (0.151)
	MS 126D$_2$ A X H 54-3 (3.45)	MS 111 A X H 136-3 (0.140)
	MS 126D$_2$ A X H 271 (3.43)	MS 126D$_2$ A X H 570-1 (0.140)
50 per cent flowering (days)	MS 23D$_2$ A X H 130-3 (41.0)	MS 5054 A X H 570 (—3.70)
	MS 5054 A X H 131 (44.5)	Jakhrana X H 136-3 (—2.68)
	MS 5054 A X H 130-3 (45.0)	MS 126D$_2$ A X H 131 (—1.93)
	MS 5141 A X H 54-3 (45.5)	MS 5054 A X H 131 (—2 03)
	MS 111 A X H 54-3 (46.0)	MS 5141 A X H 172-3 (—1.90)