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Genetic analysis of combining ability for quality characters in Basmati rice

J.P. Tyagi*, Tejbir Singh[1] and V.P. Singh

**Division of Genetics, Indian Agricultural Research Institute, New Delhi-110012, India*

ABSTRACT

Based on the general combining ability estimates for 11 grain quality characters in a set of crosses involving nine parents of indica rice. It was observed that none of parental line was found excellent for all the 11 qualitative characters. Among the nine lines, three lines viz., Pusa-1121(L7), Pusa 1463(L9) and Pusa-1176(L6) showed good general combining ability effect of maximum quality characters. Among all the crosses, P-1463 x P-44 showed high specific combining ability effects as well as high heterosis. P-1173 x Heibao, Shah-Pasand x P-44 and Bas-370 x Heibao were good specific combiner for different characters. These crosses can be used for development of hybrid in future.

Key words: *Basmati rice, combining ability, genetic analysi's*

Basmati rice is a special category of aromatic rice with a unique combination of grain quality and cooking quality. The quality traits of Basmati rice are better expressed when grown in the climatic conditions present in the north-western region of Indian subcontinent. The Basmati rice cultivation covers, a sizable area under Punjab, Haryana and western U.P. In these states, rice-wheat cropping system mainly followed under intensive agriculture systems with high input, and resulting in a very high productivity of rice in this region [Swaminathan 1998]. This leads to rapid deterioration of soil health and depletion of ground water. Therefore, diversification of agriculture is needed. Growing of high input responsive high yielding Basmati rice varieties one of the profitable. Efforts in genetic improvement of Basmati rice with regard to high yield as well as quality traits necessitate comprehensive information on genetic constitution of segregating population in hybridization programme. Therefore, in this investigation an attempt was made to get information on the combining ability of the parents and nature of gene action for qualitative traits in Basmati rice.

MATERIALS AND METHODS

The experimental material for the present investigation comprised 27 F_1's of Basmati rice involving nine lines [Basmati 370, Taraori Basmati, Shah Pasand, Pusa-1173, SB-3000, Pusa-1176, Pusa-1121, CSR-30 and Pusa-1463 and Three testers. (IRBB-60, Heibao and Pusa-44). The twenty-seven F_1 hybrids and their twelve parents were evaluated in a randomized block design with three replications at Kisan(PG) college Simbhaoli U.P during wet season 2005. Each treatment was raised in a single row of 3 metre length with a spacing of 20 x 20 cm between plants and rows. Recommended agronomical practices were followed to raise the crop. The data were recorded on five randomly selected plants in each row. Samples of 100 gm well dried paddy from each entry were dehulled and milled. Observations were recorded on eleven grain quality characters *viz*., hulling %, milling %, head rice recovery, kernel length, kernel breadth, length/breadth ratio, kernel length after cooking, kernel breadth after cooking, kernel elongation ratio, alkali spreading value and aroma. Observations were recorded for quality traits related to cooking quality. The statistical analysis was done as per procedure given by Kempthorne [1957].

RESULTS AND DISCUSSION

The analysis revealed significant differences amongst the parents and F_1's for all the characters, except for kernel length in hybrid indicating contribution of both additive and non additive gene effects to total genetic variation (Table 1). Variance due to females (lines) was significant for all the quality characters except

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elongation ratio. Variance due to male (tester) was significant for most of the quality characters except milled rice kernel length and aroma. Similarly, variations among parents vs. hybrids were significant for most of the quality characters except hulling percentage, kernel length after cooking, elongation ratio and alkali spreading value, which indicates presence of substantial heterosis in the crosses.

Analysis of variance for combining ability revealed that lines showed sufficient variability for most of the quality characters such as head rice recovery %, milled rice, kernel length, length/breadth ratio, elongation ratio, alkali spreading value and aroma while testers shoes only for head rice recovery significant variance due to line x testers interaction for the characters, hulling %, milling %, head rice recovery and elongation ratio (Panwar, 2005). The magnitude of s2 general combining ability/s2 specific combining ability the predominance of non-additive genetic variance for most of the quality characters (Shivani *et al.,* 2009). General combining ability of an inbred is its average performance across the series of hybrid combinations and it is primarily due to additive effects of genes. Therefore, the information about the gca effects of each parent is of almost importance for the identification of good parental lines.

In the present experiment, results indicated that none of the parents was found excellent for all of the 11 qualitative characters. Among the nine lines, Basmati 370 was found to be a good general combiner for milling %, kernel length and length/breadth ratio (Table 2). Line Taraori Basmati was found to be good general combiner for hulling %, milling % and aroma. Line Shah-Pasand is a good general combiner for hulling %, milling %, head rice recovery, alkali spreading value and aroma. Line Pusa-1173 has good gca for hulling %, head rice recovery, milled rice kernel length and length/breadth ratio. Line SB-3000 has good gca for hulling %, head rice recovery and elongation ratio. Line P-1176 has good gca for head rice recovery, milled rice kernel length, length/breath ratio, kernel length after cooking and elongation ratio. Line Pusa-1121 had good gca for hulling %, milling %, head rice recovery, kernel length, length/breath ratio, kernel length after cooking and aroma. Line CSR-30 has good gca for head rice recovery and length/breath ratio. Line P-1463 has good gca for hulling %, head rice recovery, kernel length, length/breath ratio, kernel length after cooking, elongation ratio. On the basis of results obtained from individual analysis, 3 lines viz., Pusa-1176, Pusa-1121 and Pusa-1463 showed good general combining ability for grain quality and cooking characteristics.

The cross showing high sca effects involving parents with good general combining ability could be exploited for hybrid development. Crosses with high sca effects and involving high x high combiners indicate additive x additive type of interaction, whereas, cross between high x low gca parents indicate additive x dominance type of interaction. The results of the present investigation showed that no cross was good for all the characters but some crosses showed good sca effects

Table 1. Analysis of variance for various qualitative characters in Basmati rice

Source of variation	d.f	Mean Sum of Squares										
		Hulling (%)	Milling (%)	HRR	KL (mm)	KB (cm)	L/B ratio	KLAC	KBAC	ER	ASV	Aroma
Replication	2	23.75	14.17	13.55	0.003	0.0007	0.009	0.007	0.00006	0.07	1.13	0.31
Parents	11	15.53**	21.50**	30.95**	0.06**	0.0007**	0.93**	0.11**	0.001**	0.13**	7.42**	3.00**
lines	8	20.74**	7.55**	37.07**	0.069**	0.0006**	0.85**	0.10**	0.309**	0.05	4.20**	0.75**
Testers	2	1.93*	22.58**	30.11**	0.0003	0.0007**	0.11**	0.303**	0.001**	0.50**	23.44**	0.00
lines VSTesters	1	1.02	71.86**	11.69**	0.13**	0.0008**	3.23**	0.36**	0.004**	0.03	1.11**	27.00**
Hybrids	26	13.40**	10.97**	40.03**	0.007	0.0003**	0.36**	0.03**	0.0005**	0.29**	4.51**	0.63**
F1's vs Parents	1	0.47	1.48**	16.55**	0.04**	0.005**	2.15**	0.001	0.0001**	0.03	0.0002	32.50**
Error	76	0.73	1.43	0.82	0.01	0.00008	0.04	0.003	0.000004	0.04	0.01	0.09

*,** = significant at 5% and 1% level

Where, HRR=Head Rice Recovery, KL= Kernel length, KB= Kernel Breadth, KLAC= Kernel length after cooking, KB= Kernel Breadth after cooking, ER=Elongation Ratio, ASV= Alkali Spreading Value

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Table 2. Estimates of gca effects of parents for various quality characters in Basmati rice

Parents	Hulling (%)	Milling (%)	HRR	KL (mm)	KB (cm)	L/B ratio	KLAC	KBAC	ER	ASV	Aroma
gca effects Line											
BAS-370	-0.20	1.65**	-0.20	-0.05*	0.01	-0.41**	-0.09*	0.00	-0.04	0.36	0.31**
TAR-BAS	-0.60*	-0.86**	-0.43	0.00	0.00	-0.07	0.00	0.00	-0.05	0.14	0.53**
SHAH-PASAND	-1.38**	-0.48*	1.35**	0.02	0.01	0.00	0.03	0.01	-0.05	-0.98**	-0.36**
PUSA-1173	1.60**	0.35	1.57**	-0.04	0.00	-0.27**	-0.03	0.00	0.02	-0.42	-0.14
SB-300	0.82*	-0.32	-4.15**	0.02	0.00	0.10	-0.01	-0.01	-0.11*	0.02	0.23
PUSA-1176	0.23	0.25	3.41**	-0.05**	-0.01	-0.17*	-0.12**	0.00	0.47**	-0.42	0.53**
PUSA-1121	-0.79*	-0.88**	-4.26**	0.06**	-0.01	0.42**	0.10	-0.01	-0.05	1.02	-0.36*
CSR-30	-0.46	0.02	1.85**	0.00	-0.01	0.18**	0.00	-0.01	-0.06	-0.20	-0.36*
Pusa -1463	0.78*	0.25	0.85*	0.05*	0.00	0.21	0.11	0.00	-0.14**	0.47	0.09
S.E.	0.25	0.21	0.26	0.01	0.00	0.06	0.02	0.00	0.04	0.32	0.10
Tester											
IRBB60	0.84**	0.59**	1.89**	0.01	0.01	-0.05	0.08**	-0.01	0.05	-0.60**	0.12
HEIBAO	-0.24	-0.73**	1.81**	0.01	0.00	0.10	-0.01	0.00	-0.14**	-0.31*	-0.02
PUSA-44	-0.59**	0.14	-0.07	-0.03	-0.01	-0.05	-0.08**	0.01	0.09	0.91**	-0.10
S.E.	0.13	0.11	0.13	0.00	0.00	0.03	0.01	0.00	0.02	0.16	0.05

KL= Kernel length, KB= Kernel Breadth L/B = length breadth KLAC= Kernel length after cooking, KB= Kernel Breadth after cooking, ER=Elongation Ratio, ASV= Alkali Spreading Value

Table 3. Estimates sca effects of cross for various quality characters in Basmati rice

Parents	Hulling (%)	Milling (%)	HRR	KL (mm)	KB (cm)	L/B ratio	KLAC	KBAC	ER	ASV	Aroma
sca crosses											
L_1 x T_1	0.22	-1.69	1.94	0.03	-0.01	0.34	0.01	0.00	-0.02	-0.95	0.21
L_1 x T_2	-0.79	2.27	-2.35	-0.04	0.00	-0.28	-0.04	0.00	0.16	1.09	0.36
L_1 x T_3	0.57	-0.58	0.41	0.01	0.01	-0.06	0.02	0.00	-0.14	-0.14	-0.57
L_2 x T_1	0.92	-0.05	-0.50	-0.01	0.00	0.03	-0.07	0.00	-0.14	-0.06	-0.01
L_2 x T_2	-2.38	1.04	-0.4	0.01	0.01	-0.12	0.05	-0.01	0.16	0.64	0.47
L_2 x T_3	1.46	1.09	0.96	0.01	0.00	0.10	0.02	0.02	-0.12	-0.58	-0.46
L_3 x T_1	-4.51	-1.57	-0.44	-0.04	-0.01	-0.11	-0.01	0.00	0.17	2.05	-0.12
L_3 x T_2	0.96	-1.21	-1.24	0.02	0.00	0.15	-0.03	0.01	-0.01	-2.25	0.02
L_3 x T_3	3.55	2.77	1.69	0.03	0.01	-0.04	0.03	-0.01	-0.16	0.20	0.10
L_4 x T_1	0.57	-0.30	0.67	0.00	0.00	-0.01	0.04	0.00	0.11	-0.51	0.32
L_4 x T_2	2.67	3.08	3.20	0.03	0.00	0.16	0.00	0.00	-0.1	0.53	-0.20
L_4 x T_3	-3.23	-2.79	-3.87	-0.03	0.00	-0.18	-0.04	0.00	-0.10	-0.02	-0.12
L_5 x T_1	-1.16	-1.44	-1.78	0.01	0.00	-0.01	-0.02	0.01	-0.02	1.05	0.10
L_5 x T_2	1.11	1.06	0.59	-0.02	-0.01	0.05	0.02	0.00	0.16	-1.58	-0.09
L_5 x T_3	0.05	0.38	1.19	0.00	0.00	-0.03	0.01	0.00	-0.14	0.53	-0.01
L_6 x T_1	-0.08	-0.47	0.67	0.06	-0.01	0.52	0.11	0.00	-0.49	-0.84	-0.35
L_6 x T_2	-0.06	-0.54	-1.30	-0.04	-0.01	-0.55	-0.03	0.01	-0.38	0.53	-0.20
L_6 x T_3	0.14	0.98	0.63	-0.01	0.01	0.03	-0.09	-0.02	0.87	0.31	0.54
L_7 x T_1	0.23	1.06	-2.67	-0.01	-0.01	-0.30	0.03	0.00	0.12	0.38	-0.12
L_7 x T_2	-0.55	-1.83	2.37	0.03	0.00	0.46	-0.01	-0.02	-0.03	0.09	0.02
L_7 x T_3	0.33	0.78	0.30	-0.02	0.01	-0.16	-0.02	0.01	-0.09	-0.47	0.10
L_8 x T_1	3.41	3.37	0.22	0.00	0.00	-0.24	0.00	0.00	0.05	-0.40	-0.12
L_8 x T_2	-0.40	-0.41	3.59	0.00	0.00	-0.43	0.03	0.00	0.14	0.31	0.02
L_8 x T_3	3.01	-2.96	-3.81	0.00	-0.01	0.27	-0.03	0.00	-0.19	0.09	0.10
L_9 x T_1	0.41	1.06	1.89	-0.04	0.00	-0.21	-0.09	0.00	0.12	-0.73	0.10
L_9 x T_2	-0.55	-1.38	-4.41	0.02	0.00	0.13	0.00	0.01	-0.17	0.64	-0.42
L_9 x T_3	0.14	0.32	2.52	0.02	0.00	0.08	0.09	-0.01	0.06	0.06	0.32
S.E.	0.35	0.30	0.37	0.01	0.00	0.08	0.02	0.00	0.05	0.45	0.14

Testers' name T_1=IRBB60, T_2=HEIBAO, T_3=PUSA-44, Name of lines L_1=BAS-370, L_2=TAR-BAS, L_3=SHAH-PASAND, L_4=PUSA-1173, L_5=SB-3000, L_6=PUSA-1176, L_7=PUSA-1121, L_8=CSR-30, L_9=PUSA-1463, KL= Kernel length, KB= Kernel Breadth L/B = length breadth KLAC= Kernel length after cooking, ER=Elongation Ratio, ASV= Alkali Spreading Value

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for a number of characters (Table 3). Cross between Basmati-370 x Heibao was found to be good specific combiner for milling %, elongation ratio, alkali spreading value and aroma. It was observed that the cross Shah-Pasand x Pusa-44 was good specific combiner for hulling % and milling %. The cross Pusa-1173 x Heibao expressed high sca effects for hulling %, milling %, head rice recovery, length/breadth ratio and alkali spreading value, whereas the cross P-1463 x P-44 expressed high sca effects for head rice recovery and aroma.

Among all the crosses, P-1463 X P-44 showed high sca effects as well as high heterosis. P- 1173 x Heibao, Shah-Pasand x P-44 and Basmati-370 x Heibao were good specific combiners for different characters. These crosses can be used for development of varieties in future.

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