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Combining ability and heterosis among elite bacterial blight resistant lines in rice (*Oryza sativa* L.)

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ABSTRACT

Combining ability analysis for yield and other agronomic traits were made in F_1 and F_2 diallel of seven varieties resistant to bacterial blight of rice revealed highly significant combining ability variances for plant height, panicle number/plant, panicle length, spikelet number panicle^{-1}, grain number panicle^{-1}, total dry matter, harvest index and grain yield plant^{-1} indicating importance of non-additive gene action in their expression. The parent BJ 1 was the best combiner for most characters including yield. Parent BBL 307 and C 702015 were good combiners for days to flowering and spikelet and grain number/panicle. SCA effects indicted significant sea × generation interaction. The crosses C 702015 / IR 50400, BBL 307 / BJ 1, BBL 180 / C 702015 and RP 633 / RP 2151 recorded the highest sea effects for yield. Maximum value for relative and heterobeltiosis were 67.14 and 52.35 per cent, respectively. The above four crosses alongwith BBL 307 / BJ 1, BBL 307 / C 702015 and BBL 307 / IR 50400, BBL 180 / C 702015, C 702015 / IR 50400 and RP 633 / RP 2151 were identified as the best hybrids based on superior per se performance, heterosis and specific combining ability effects for exploiation.

Key words: *Rice, bacterial blight, gene action, combining ability, heterosis*

The bacterial blight (BB) caused by *Xanthomonas oryzae pv. Oryzae* is one of the most devastating diseases of rice incurring heavy yield losses and even upto 81.3 per cent in susceptible cultivars under higher input management. Combining ability studies are frequently used by breeder to evaluate the parental lines for their usefulness in crosses and to assess the nature of gene action involved in their inheritance. There is dearth of information on gene action and combining ability of elite BB resistant lines. Therefore, the study is undertaken to determine the nature of gene action and combining ability of parents and crosses and extent of heterosis for formulating strategy of breeding BB resistant varieties to BB prone areas.

F_1 and F_2 half diallel (excluding reciprocal crosses) from seven cultuvars of indigenous and exotic origin and exhibiting resistant [BBL 180-5-1-41 (P_1), BBL 307-4-1-2-1 (P_2), RP 633-519-1-3-8-1 (P_3) and IR 50400 (P_4)] and moderately resistant [BJ 1 (P_5), C 702015 (P_6) and RP 2151-40-1 (P_7)] reaction to BB were evaluated with parents, all in a randomized block design with three replications with a spacing of 20 × 15 cm. Parental lines and F_1 comprised single row whereas individual F_2's were in 15 rows of 1.5 m length each, at the rate of single seedling hill^{-1}. Observations were recorded for ten characters (Table 1) from five random and competitive plants for F_1 and parents and 20 in F_2 and average of these were used in analyzing combining ability as suggested by Griffing (1965). Estimates of relative heterosis and heterobeltiosis were made.

General combining ability (GCA) and Specific combining ability (SCA) variances for combining ability were highly significant for almost all the characters in both the diallel. Ratio of GCA and SCA variances were higher for all the characters (0.05 - 0.68) except for days to flowering (54.0 in F_1 and 20.18 in F_2) and plant height (2.12) indicating predominance of non-additive gene action in their expression. For days to 50 % flowering, additive gene action was more important as also observed by several workers (Verma *et al.*, 1995; Dwivedi *et al*, 1999 and Singh and Kumar, 2004).

Table 1. Estimates of general combining ability effects of parents in F_1 and F_2 diallels

Parent	Generation (diallel)	Days to 50% flowering	Plant height	Panicle number plant^{-1}	Panicle length	Spikelet number panicle^{-1}	Grain number panicle^{-1}	Total dry matter plant^{-1}	Harvest index	Grain yield plant^{-1}	*Per se* perfor-mance
BBL 180	F_1	-6.45**	-2.18**	0.17	0.64**	-7.50**	-2.39**	2.55**	2.12*	-0.20**	23.17
	F_2	-6.18**	-3.69**	-0.48**	-0.01	-5.06**	-6.59**	-2.09	0.78	-1.07**	
BBL 307	F_1	-7.57**	0.58	0.95*	0.40*	21.08**	14.22**	-0.06	2.40**	1.80*	24.10
	F_2	-8.41**	-2.00**	-0.33*	-0.09	2.55*	3.60**	-1.01	-5.57**	0.29	
BJ 1	F_1	-1.79**	10.64**	3.16**	0.23	-12.83**	-10.90**	18.22**	0.59	6.98**	41.60
	F_2	-1.57**	16.19**	2.63**	0.83	-0.31	-2.07*	20.46**	-3.44**	4.29**	
RP 633	F_1	8.84**	0.99**	-0.59	0.00	14.77**	9.50**	2.60**	-0.73	-0.20**	23.00
	F_2	8.84**	-2.79**	-0.56**	0.20	-1.57	-3.39**	-1.66**	0.59	-0.14	
C 702015	F_1	-8.38**	-1.42**	-1.41**	-0.16	1.90**	5.63**	-5.67**	1.54	0.58**	19.07
	F_2	-8.48**	0.16	-0.74**	0.34**	10.46**	13.27**	-5.54**	0.93	-1.12**	
RP 2151	F_1	4.99**	0.31	-0.63	0.29	7.70**	5.53**	7.65**	-0.43	-3.22**	21.17
	F_2	5.56**	-0.27	0.06	0.16	12.69**	8.43**	-2.93**	2.60**	-0.18	
IR 50400	F_1	10.36**	-8.93**	-1.60**	-1.43**	25.13**	-21.67**	-9.99**	-1.26	-4.58**	15.70
	F_2	10.77**	-7.60**	-0.58**	-1.43**	-18.75**	-13.41**	-7.21**	4.02**	-2.05**	
SE (gi)	F_1	0.37	0.42	0.46	0.20	0.20	0.78	0.54	0.99	0.02	
	F_2	0.37	0.66	0.16	0.12	1.31	1.02	0.83	0.83	0.41	

* and ** significant at P = 0.05 and 0.01, respectively.

The estimates of GCA effects (Table 1) revealed that none of the parents exceled for all the characters suggesting the values of multiple crosses alone to affect substantial improvement in grain yield. However, the best combining parent in both the diallel sets was BJ 1 followed by BBL 307, C 702015, BBL 180 and RP 2151. Based on GCA effects in F_2 diallel, BBL 307 was best combiner for most of the characters.

Parental *per se* performance has been suggested as an useful index in rice for selecting parents for hybridization (Verma *et al.*, 1995 and Dwivedi *et al.*, 1999). In this study as well, the lines having higher *per se* performance for grain yield and the components giving higher GCA effects for the respective characters (Table 1) suggest use of lines like BJ 1 and BBL 307 in hybridization programme.

Table 2. SCA effects, heterosis and *per se* performance of top hybrids for grain yield and important component characters

Crosses+	SCA of crosses: Yield plant^{-1} F_1	Yield plant^{-1} F_2	Harvest index F_1	Harvest index F_2	Total dry matter F_1	Total dry matter F_2	Plant height F_1	Plant height F_2	Heterosis (%): Relative	Hetero-beltiosis	*Per se* perfor-mance	GCA of parents
P_6/P_5	9.4**	3.3*	0.4	0.2	24.1**	10.7**	6.0**	2.2*	59.0	51.2	32.0	L/L
P_2/P_5	8.8**	-6.0**	3.1	13.2**	30.8**	-12.1	11.7**	-1.7*	37.9	8.9	45.3	H/H
P_1/P_6	8.3**	-5.0**	3.3+	-8.0**	13.7**	-4.1**	0.4	-8.3**	67.1	52.3	35.3	L/L
P_3/P_7	7.8**	-2.3**	-0.5	-3.5**	20.0**	-1.3	3.8**	2.4**	45.5	39.7	32.1	H/L
P_2/P_7	7.3**	-0.5	-3.6**	9.5**	26.9**	-1.6	21.0**	-1.0	48.6	39.5	33.6	H/L
P_1/P_3	6.1**	-1.8	1.5	1.5	12.5**	2.9	-1.6*	-1.0	44.9	44.3	33.4	L/H
P_2/P_6	5.2**	3.7**	-1.0	-9.6**	15.3**	6.1**	-3.1**	1.7*	58.6	42.0	34.2	H/L
P_5/P_3	3.0**	-1.4	-6.5**	-7.0**	26.9**	10.8**	11.5**	-0.6	16.2	9.8	37.5	H/H
P_7/P_4	+3.0**	+2.8**	-3.4**	3.1*	12.7**	7.7**	-5.7**	1.4	24.4	8.3	22.9	L/L
P_2/P_4	0.5	-4.5**	2.6	6.9**	-4.3**	2.0	12.7**	5.4**	23.0	5.7	25.5	H/L

*Range of heterobeltiosis -36.2 to 67.4 % and relative heterosis (-51.8 to 52.3 %)

+ P_1 = BBL 180, P_2 = BBL 307, P_3 = RP 633, P_4 = IR 50400, P_5 = BJ 1, P_6 = C 702015

The combining ability studies indicated only 20 % of the crosses with significant and positive SCA effect in F_1 diallel involved high/high (20%) as compared to none of the eight crosses in F_2 involved high/high parents. Thus, it conclusively proves dominance and epistasis effects controlling the inheritance of grain yield per plant as also reported by Dwivedi *et al,* (1999) and Satyanarayana *et al,* (2000).

The estimates of relative heterosis and heterobeltiosis ranged between -36.18 to 67.14 % and -51.82 to 52.35 %, respectively. The top hybrids recording the highest SCA effects for grain yield were shown to manifest high heterosis and high to moderate *per se* performance (Table 2). For example, the hybrid BBL 307/BJ 1 and BJ 1/RP 633 with very high SCA effects for grain yield revealed significant heterosis and *per se* performance that involved both the parents as good general combiners. Such combinations are due to interaction of dominant genes contributed by the parents and can best be exploited by the conventional breeding methods for isolation of high yielding pure lines as transgressive segregants. This hybrid can be exploited for heterosis breeding as well as it would exhibit resistant reaction to BB due to dominant Xa21 gene for BB resistance (Pandey *et al.*, 1999) alongwith higher yield. There is a possibility to obtain desirable transgressive segregants from these combinations if cyclic or biparental breeding programme are adopted.

It was noteworthy that most of the hybrids having higher SCA effects for yield in both the diallels were combinations of indigenous/exotic types. It emphasizes the importance of combining two diverse germplasm to create maximum genetic variability which is the prime need and this alone would help in raising yield levels through selection in breeding programme.

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