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COMBINING ABILITY ANALYSIS OF SOME MORPHO-PHYSIOLOGICAL TRAITS IN BASMATI RICE

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Abstract

Combining ability analysis was conducted on 12 parental genotypes and their 27 F_1 hybrids to identify superior genotypes based on morpho-physiological traits in Basmati rice following line × tester mating design. Highly significant genetic variability was present among treatments, parents, parents vs. crosses, crosses, testers and line × tester interaction for flag leaf area, panicle density, harvest index, biological yield per plant and yield per plant. However, lines were significant for all the traits except flag leaf area and yield per plant. Preponderance of non-additive gene effects was realized by higher value of specific combining ability comparing to general combining ability, ratio of variance of general combining ability to variance of specific combining ability and degree of dominance. Four parental genotypes for grain yield per plant, 5 for flag leaf area, 4 for plant height, 5 for panicle density, 4 for harvest index and 3 for biological yield per plant were found good general combiners based on significant high mean performance and GCA effects. Seven hybrids for yield per plant, 4 for flag leaf area, 7 for plant height, 7 for panicle density, 4 for harvest index and 3 for biological yield per plant excelled other hybrids in attaining high mean performance and SCA effects, hence these are recommended for heterosis breeding to improve yield and yield related traits. Based on SCA effects of the hybrids in relation to GCA effects of their parents, Kashmir Basmati × Basmati-385 is recommended for recombination breeding with early selection of desired plants whereas DM-107-4 × Basmati-385 and Super Basmati × Basmati-385 are proposed for recombination breeding with the condition of delayed selection of superior genotypes to develop potential varieties.

Introduction

The ability of parents to combine well cannot be judged by phenotypic performance and adaptation qualities (Khattak, 1999). Therefore, the choice of parental material and breeding methodology becomes convoluted for improvement or development of new cultivars (Thirumeni *et al*., 2000). Combing ability analysis provides guide line for the assessment of relative breeding potential of the parents and help in choice of parents (Gnanasekaran *et al*., 2006) which may be hybridized either to exploit hybrid vigor by accumulating unfixable gene effects or to evolve cultivars by accumulating fixable gene effects (Nadarajan & Gunasekaran, 2005).

Basmati rice has narrow genetic base. It does not produce full spectrum of recombinants through hybridization with elite indica lines to develop high yielding cultivars (Singh *et al*., 2000). The scarcity of donor parents to improve quality parameters is another issue associated with Basmati rice (Akram & Sagar, 1999). So far, 9 Basmati rice cultivars have been released for general cultivation in Pakistan, but its average yield of 1710 kg per hectare remained low (Anon., 2008-2009). In order to develop high yielding Basmati rice cultivars, selection of potential parents could generate better recombinants through crossing with other counterparts. In this regard, combining ability analysis of the breeding material for yield and its contributing traits assumes vital importance. The general combining ability could identify superior parental genotypes whereas specific combining ability helps in identification of good hybrids which may ultimately lead to the development of hybrids (Saleem *et al*., 2009).

Yield is a polygenic trait with complex gene action. Appreciable amount of literature is available on combining ability of major yield components in Basmati rice (Saleem *et al*., 2010). However, little information is available about combing ability of certain morpho-physiological traits in Basmati rice. Correlation studies have indicated that grain yield is positively correlated with leaf characters, biological yield and harvest index (Thakur *et al*., 1998; Padmaja *et al*., 2002; Verma *et al*., 2002; Mishra *et al*., 2003). Vegara (1991) reported that better rice cultivars has higher harvest index. On the other hand, Surek & Beser (2003) suggested that higher biological yield and harvest index should be considered together in selection of superior genotypes due to their indirect effects on each other.

Line × tester technique (Kempthorne, 1957) provides information on general and specific combining ability. The objective of the present research was to assess combining ability of various morpho-physiological traits for the identification of suitable parental genotypes and hybrids. The identification/selection of such genotypes would not only broaden the genetic base of Basmati rice but it would also enhance our existing knowledge and help in the development of potential hybrids, cultivar or germplasm with valuable economic traits.

Materials and Methods

The study was conducted at Nuclear Institute for Agricultural and Biology (NIAB), Faisalabad. The breeding material comprised of 12 pure Basmati rice genotypes. Nine lines *viz*., Basmati-370, DM-2, DM-107-4, DM-16-5-1, Kashmir Basmati, Basmati-Pak, Basmati 2000, Super Basmati and Shaheen Basmati were crossed with three testers *viz*., Basmati-385, DM-25 and EL-30-2-1 to produce 27 F_1 hybrids according to line × tester fashion (Kemthorne, 1957). Lines were used as female whereas testers as male parents. The experiment was laid out in randomized complete block design (RCBD) with three replications in field during 2005-06. Standard cultural practices were followed to grow the healthy crop. Ten plants were selected randomly from each entry in each replication to record data on flag leaf area (cm^2), plant height (cm), panicle density, harvest index (%), biological yield per plant (g) and yield per plant (g). Some initial results of agronomic traits of the same study had already been reported (Saleem *et al*., 2010).The analysis of variance was done as cited by Steel & Torrie (1980). Analyses of combining ability and other parameters were performed according to Singh & Chaudhary (1985). Significant and positive general combining ability (GCA) and specific combining ability (SCA) effects were taken as high, non-significant as average and significant negative as low. However, in case of plant height, significant negative combining ability effects were taken as high, significant positive as low and non-significant as average.

Results and Discussion

Mean performance of lines, testers and their hybrids indicated high genetic variability for flag leaf area, plant height, panicle density, harvest index, biological yield per plant and yield per plant (Table 1). Analysis of variance, estimates of genetic components and contribution of parents and hybrids to the total variance are presented in Table 2. The analysis of variance revealed highly significant differences among treatments, parents, parents *vs*. crosses, crosses, testers and lines × testers interaction for flag leaf area, plant height, panicle density, harvest index, biological yield per plant and grain yield per plant. Lines were significant for all the traits except flag leaf area and yield per plant. Major role of non-additive gene effects in the inheritance of all traits was observed by higher value of variance of specific combining (σ^2_{SCA}) than the variance of general combining ability, ratio of $\sigma^2_{GCA}/\sigma^2_{SCA}$ being less than one and degree of dominance $(\sigma^2_D/\sigma^2_A)^{1/2}$ being greater than one. Several workers have reported preponderance of non-additive gene effects for plant height (Banumathy *et al*., 2003;), harvest index (Hosseini *et al*., 2005) and grain yield per plant (Manonmani *et al*., 2005; Gnanasekaran *et al*., 2006). Surek & Korkut (1998) reported additive gene effects for biological yield per plant. The contribution of lines was more than testers and line × tester interaction for the expression of plant height (73.20%) and biological yield per plant (46.96%) while contribution of testers was more than lines for flag leaf area (35.71%), panicle density (45.78%), harvest index (53.15%) and yield per plant (33.99%). Line × tester interaction contribution was higher than lines and tester for flag leaf area (39.57%) and yield per plant (36.29%).

The general combing ability effects of the parents are presented in Table 3. For grain yield per plant, four lines *viz*., Basmati 2000, Kashmir Basmati, DM-107-4, and Super Basmati and one tester Basmati-385 showed significant and positive GCA effects. Line DM-107-4 and tester Basmati-385 showed significant and desirable GCA effects for all the traits except biological yield per plant. Basmati 2000 showed desirable GCA effects for flag leaf area, panicle density and harvest index whereas Kashmir Basmati for biological yield per plant and Super Basmati for plant height and biological yield per plant. Consideration of significant high mean performance (Table 1) and GCA effects (Table 3) led to the identification of Basmati 2000, Super Basmati , Kashmir Basmati among lines and Basmati-385 among testers as good general combiners for grain yield per plant; Basmati 2000, DM-2, Basmati-370, DM-107-4 and Basmati-385 for flag leaf area; DM-2, DM-107-4, Super Basmati and Basmati-385 for short plant height; Basmati-370, DM-16-5-1, Shaheen Basmati, Basmati-385 and DM-25 for panicle density; DM-107-4, Basmati 2000, Shaheen Basmati and Basmati-385 for harvest index and Kashmir Basmati, Basmati-Pak and EL-30-2-1 for biological yield per plant. Results were similar to those of Shehata *et al*., (2004) for flag leaf area, Punitha *et al*., (2004) for plant height, Gnanasekaran *et al*., (2006) for harvest index and Kumar *et al*., (2007) for grain yield per plant. High GCA effects show presence of favorable genes with additive type of gene action therefore, a multiple crossing programme involving good general combiners isolated in current study is recommended to identify superior genotypes as proposed by Nadarajan & Gunasekaran (2005).

Table 1. Mean performance of parents and hybrids for line × tester analysis in rice genotypes.

Parents/Hybrids	Flag leaf area (cm^2)	Plant height (cm)	Panicle density	Harvest index (%)	Biological yield per plant (g)	Yield per plant (g)
Lines						
Basmati-370	47.54**	170.50**	5.76**	20.29**	85.13**	20.03
DM-2	47.70**	92.83**	4.77	27.55**	60.08**	19.22**
DM-107-4	49.93**	106.67**	3.87**	27.96**	61.38**	19.90
DM-16-5-1	43.89**	140.43**	5.60**	23.47	76.84	20.90*
Kashmir Basmati	32.80**	156.00**	4.77	21.41**	84.04**	20.87*
Basmati-Pak	39.24**	160.00**	3.49**	15.75**	91.92**	16.77**
Basmati 2000	62.93**	138.50**	4.69	25.93**	75.36	22.48**
Super Basmati	42.60**	116.07**	4.56*	24.25	78.58	22.07**
Shaheen Basmati	42.07**	134.53	5.45**	24.77**	73.04*	20.97*
Grand Mean ± S.E.	45.41±0.40	135.06±0.84	4.77±0.08	23.49±0.48	76.26±1.48	20.36±0.22
C.D. (0.05)	0.83	1.75	0.17	0.99	3.07	0.46
C.D. (0.01)	1.13	2.38	0.23	1.35	4.17	0.62
Testers						
Basmati-385	49.40**	123.77**	5.86**	26.47**	95.77**	29.38**
DM-25	41.74**	140.50**	5.68**	22.29	84.48**	21.80*
EL-30-2-1	43.40	145.43**	2.90**	15.66**	95.28*	17.33**
Grand Mean ± S.E.	44.85±0.61	136.57±0.41	4.81±0.03	21.47±0.32	91.84±0.80	22.84±0.37
C.D. (0.05)	1.69	1.13	0.07	0.89	2.22	1.02
C.D. (0.01)	2.81	1.88	0.12	1.47	3.68	1.69
Hybrids						
Basmati-370 × Basmati-385	63.40**	151.40**	6.52**	24.98	115.93*	33.59
Basmati-370 × DM-25	59.82	159.47**	5.10	20.49**	113.45	27.02**
Basmati-370 × EL-30-2-1	57.73	152.03**	5.26	18.60**	106.85**	23.03**
DM-2 × Basmati-385	69.25**	121.60**	4.80**	27.79**	85.04**	27.34**
DM-2 × DM-25	59.22	122.73**	4.65**	26.63	81.44**	25.10**

Table 1 (Cont'd.).

Parents/Hybrids	Flag leaf area (cm^2)	Plant height (cm)	Panicle density	Harvest index (%)	Biological yield per plant (g)	Yield per plant (g)
DM-2 × EL-30-2-1	53.31*	122.67**	4.48**	21.82**	122.79**	31.19
DM-107-4 × Basmati-385	62.40**	111.03**	6.14**	32.20**	110.57	41.27**
DM-107-4 × DM-25	60.65*	127.10**	5.43*	28.07**	99.48**	32.25
DM-107-4 × EL-30-2-1	57.05	127.33**	4.60**	21.17**	117.10*	28.81**
DM-16-5-1 × Basmati-385	68.96**	128.07**	6.37**	31.17**	102.95**	37.20**
DM-16-5-1 × DM-25	54.41	145.00**	5.79**	27.35**	86.74**	27.53**
DM-16-5-1 × EL-30-2-1	50.06**	145.17**	4.29**	19.84**	114.07	25.77**
Kashmir Basmati × Basmati-385	50.44**	135.40**	5.55**	27.06*	126.87**	39.74**
Kashmir Basmati × DM-25	59.68	148.27**	5.44*	25.71	120.00**	35.32*
Kashmir Basmati x EL-30-2-1	47.49**	161.77**	4.77**	18.84**	142.35**	31.07
Basmati-Pak × Basmati-385	52.04**	142.67**	5.81**	27.96**	136.72**	44.21**
Basmati-Pak × DM-25	50.07**	155.13**	4.60**	21.69**	103.61**	25.69**
Basmati-Pak × EL-30-2-1	46.49**	153.60**	3.28**	18.16**	132.01**	27.73**
Basmati 2000 × Basmati-385	80.60**	135.83**	6.22**	31.58**	98.46**	35.96**
Basmati 2000 × DM-25	65.50**	146.27**	6.36**	29.25**	111.52	37.41**
Basmati 2000 × EL-30-2-1	41.95**	147.33**	5.81**	27.52**	122.91**	38.89**
Super Basmati × Basmati-385	64.04**	124.70**	5.68**	29.21**	123.93**	41.80**
Super Basmati × DM-25	44.58**	124.07**	4.21**	21.22**	105.85**	25.80**
Super Basmati × EL-30-2-1	51.66**	134.93**	3.54**	21.73**	135.94**	33.80
Shaheen Basmati × Basmati-385	57.25	124.07**	6.29**	30.62**	95.30**	33.67
Shaheen Basmati × DM-25	57.79	141.46**	6.11**	28.09**	103.77**	33.51
Shaheen Basmati × EL-30-2-1	52.37**	146.60**	4.24**	26.60	110.40	33.57
Grand Mean ± S.E.	56.97±1.62	138.36±0.99	5.24±0.08	25.38±0.67	112.08±1.91	32.53±1.24
C.D. (0.05)	3.25	1.81	0.16	1.35	3.83	2.50
C.D. (0.01)	4.27	2.38	0.21	1.77	5.04	3.28

*,** = Significant at 0.05 and 0.01 level of probability, respectively, C.D. = Critical Difference, S.E. = Standard Error

Table 2. Mean squares for analysis of variance, estimates of genetic components and contribution of lines, testers and line × tester to the total variance in rice genotypes.

Source	d.f.	Flag leaf area (cm^2)	Plant height (cm)	Panicle density	Harvest index (%)	Biological yield per plant (g)	Yield per plant (g)
Replications	2	3.12	0.29	0.001	0.39	9.17	1.18
Treatments	38	285.67**	823.24**	2.59**	57.06**	1294.59**	164.85**
Parents	11	160.60**	1519.23**	2.76**	51.18**	412.32**	30.26**
Parents vs. Crosses	1	3412.49**	212.94**	5.10**	143.43**	25389.22**	3325.39**
Crosses	26	218.31**	552.25**	2.42**	56.23**	741.14**	100.24**
Lines	8	175.41	1313.72**	2.83**	64.73**	1131.32*	96.83
Testers	2	1013.36**	1281.45**	14.40**	388.51**	2699.21**	442.98**
Lines × Testers	16	140.39**	80.37**	0.72**	10.44**	301.28**	59.10**
Error	76	5.90	2.49	0.02	1.20	10.49	3.43
σ^2_{GCA}		1.61	9.74	0.04	0.94	9.08	0.85
σ^2_{SCA}		44.83	25.96	0.23	3.08	96.93	18.56
$\sigma^2_{GCA}/\sigma^2_{SCA}$		0.04	0.38	0.15	0.31	0.09	0.05
σ^2_A		3.22	19.47	0.07	1.89	18.15	1.70
σ^2_D		44.83	25.96	0.23	3.08	96.93	18.56
$(\sigma^2_D/\sigma^2_A)^{1/2}$		3.73	1.15	1.82	1.28	2.31	3.31
Contribution (%) of Lines		24.72	73.20	35.93	35.42	46.96	29.72
Testers		35.71	17.84	45.78	53.15	28.02	33.99
Line × Tester		39.57	8.96	18.29	11.43	25.02	36.29

*, ** = Significant at 0.05 and 0.01 level of probability, respectively

Table 3. General combining ability effects of parents for different morpho-physiological traits in rice.

Parents	Flag leaf area (cm^2)	Plant height (cm)	Panicle density	Harvest index (%)	Biological yield per plant (g)	Yield per plant (g)
Lines						
Basmati-370	3.34**	15.94**	0.39**	-4.03**	0.00	-4.65**
DM-2	3.62**	-16.03**	-0.59**	0.03	-15.65**	-4.65**
DM-107-4	3.06**	-16.54**	0.15**	1.76**	-3.03**	1.58*
DM-16-5-1	0.84	1.05*	0.25**	0.74*	-10.82**	-2.36**
Kashmir Basmati	-4.43**	10.12**	0.02	-1.51**	17.66**	2.85**
Basmati-Pak	-7.43**	12.11**	-0.67**	-2.78**	12.04**	0.02
Basmati 2000	5.71**	4.79**	0.89**	4.07**	-1.11	4.89**
Super Basmati	-3.54**	-10.46**	-0.75**	-1.33**	9.83**	1.27*
Shaheen Basmati	-1.17	-0.98	0.31**	3.05**	-8.92**	1.05
S.E. (GCA effects for line)	0.81	0.53	0.05	0.37	1.08	0.62
Testers						
Basmati-385	6.18**	-7.83**	0.70**	3.79**	-1.44*	4.67**
DM-25	-0.11	2.70**	0.06*	0.01	-9.20**	-2.57**
EL-30-2-1	-6.07**	5.13**	-0.76**	-3.80**	10.64**	-2.10**
S.E. (GCA effects for tester)	0.47	0.30	0.03	0.21	0.62	0.36

*,** = Significant at 0.05 and 0.01 level of probability, respectively S.E. = Standard Error

Specific combining ability effects are presented in Table 4. None of the hybrids exhibited significant and desirable SCA effects for all the parameters. For grain yield per plant, seven hybrids viz., Basmati-Pak × Basmati-385, Super Basmati × Basmati-385, DM-107-4 × Basmati-385, Basmati 2000 × EL-30-2-1, Basmati 2000 × DM-25, DM-16-5-1 × Basmati-385 and Kashmir Basmati × DM-25 were found good specific combiners based on higher mean performance (Table 1) and SCA effects. These results are in line with those of Panwar (2005) and Petchiammal & Kumar (2007) who reported several promising specific combiners based on high *per se* performance and SCA effects for yield per plant in rice. For other traits, sets of good specific combiners were identified based on high mean performance and SCA effects. In this regard, 4 hybrids viz., DM-16-5-1 × Basmati-385, Basmati 2000 × Basmati-385, Basmati 2000 × DM-25 and Super Basmati × Basmati-385 were important for flag leaf area; 7 hybrids like DM-2 × DM-25, DM-2 × EL-30-2-1, DM-107-4 × Basmati-385, 16-5-1 × Basmati-385, Kashmir Basmati × Basmati-385, Super Basmati × DM-25 and Shaheen Basmati × Basmati-385 were ideal for short stature; 7 hybrids viz., Basmati-370 × Basmati-385, DM-16-5-1 × Basmati-385, DM-16-5-1 × DM-25, Basmati Pak × Basmati-385, Basmati 2000 × EL-30-2-1, Super Basmati × Basmati-385 and Shaheen Basmati × DM-25 were attractive for higher panicle density; 4 hybrids such as DM-107-4 × Basmati-385, Basmati Pak × Basmati-385, Basmati 2000 × EL-30-2-1 and Super Basmati × Basmati-385 were desirable for higher harvest index while three hybrids viz., Basmati-370 × Basmati-385, DM-2 × EL-30-2-1 and Basmati Pak × Basmati-385 were potential hybrids for higher biological yield per plant. Peng & Virmani (1990) reported then hybrids showing highly significant desirable SCA effects for flag leaf area while Panwar (2005) for plant height, harvest index, biological yield and grain yield per plant. Heterosis breeding is recommended for good specific combiners isolated in present investigation for yield and its various morpho-physiolgical traits.

High SCA effects show predominance of non-additive gene effects mainly dominance gene effects (Nadarajan & Gunasekaran, 2005). Hybrids which show non-significant SCA effects (average effects) but originated from parents having high GCA effects (additive gene effects) can be used for recombination breeding with early selection of desirable segregants (Nadarajan & Gunasekaran, 2005). The number of such hybrids in present study however, was low. In this regard, Kashmir Basmati × Basmati-385 for yield per plant; DM-2 × Basmati-385 for flag leaf area; DM-107-4 × Basmati-385, DM-107-4 × DM-25, Basmati 2000 × DM-25 and Shaheen Basmati × Basmati-385 for panicle density; DM-16-5-1 × Basmati-385 for harvest index; Kashmir Basmati × EL-30-2-1, Basmati-Pak × EL-30-2-1 and Super Basmati × EL-30-2-1 for biological yield per plant were the potential hybrids. Hybrids which indicated high SCA and derived from parents having high GCA effects can also be used for recombination breeding. However, the selection of superior genotypes for cultivar development must be delayed to later generations to allow fixation of maximum homozygsity (Nadarajan & Gunasekaran, 2005). These hybrids were DM-107-4 × Basmati-385 and Super Basmati × Basmati-385 for yield per plant; Basmati 2000 × Basmati-385 for flag leaf area; DM-107-4 × Basmati-385 for short stature; Basmati-370 × Basmati-385, DM-16-5-1 × Basmati-385, DM-16-5-1 × DM-25 and Shaheen Basmati × DM-25 for panicle density and DM-107-4 × Basmati-385 for harvest index.

Table 4. Specific combining ability effects of hybrids for different morpho-physiological traits in rice.

Hybrids	Flag leaf area (cm^2)	Plant height (cm)	Panicle density	Harvest index (%)	Biological yield per plant (g)	Yield per plant (g)
Basmati-370 × Basmati-385	-3.10*	4.93**	0.20*	-0.17	5.29**	1.04
Basmati-370 × DM-25	-0.39	2.47**	-0.59**	-0.87	10.57**	1.71
Basmati-370 × EL-30-2-1	3.48*	-7.40**	0.39**	1.04	-15.86**	-2.75*
DM-2 × Basmati-385	2.47	7.09**	-0.54**	-1.41*	-9.95**	-5.22**
DM-2 × DM-25	-1.26	-2.30*	-0.05	1.21	-5.78**	-0.20
DM-2 × EL-30-2-1	-1.22	-4.80**	0.59**	0.20	15.73**	5.41**
DM-107-4 × Basmati-385	-3.80**	-2.96**	0.05	1.27*	2.95	2.49*
DM-107-4 × DM-25	0.73	2.58**	-0.02	0.92	-0.37	0.71
DM-107-4 × EL-30-2-1	3.09*	0.38	-0.03	-2.18**	-2.58	-3.20**
DM-16-5-1 × Basmati-385	4.97**	-3.51**	0.19*	1.26	3.13	2.37*
DM-16-5-1 × DM-25	-3.29*	2.89**	0.24**	1.22	-5.31**	-0.07
DM-16-5-1 × EL-30-2-1	-1.68	0.62	-0.43**	-2.48**	2.18	-2.29*
Kashmir Basmati × Basmati-385	-8.28**	-5.25**	-0.42**	-0.60	-1.44	-0.31
Kashmir Basmati × DM-25	7.26**	-2.91**	0.12	1.83**	-0.54	2.52*
Kashmir Basmati × EL-30-2-1	1.02	8.16**	0.28**	-1.23	1.97	-2.21*
Basmati-Pak × Basmati-385	-3.68*	0.03	0.55**	1.57*	14.04**	7.00**
Basmati-Pak × DM-25	0.65	1.97*	-0.03	-0.92	-11.30**	-4.28**
Basmati-Pak × EL-30-2-1	3.03*	-2.00*	-0.52**	-0.65	-2.74	-2.71*
Basmati 2000 × Basmati-385	11.73**	0.52	-0.60**	-1.66**	-11.07**	-6.14**
Basmati 2000 × DM-25	2.93*	0.43	0.16	-0.20	9.76**	2.56*
Basmati 2000 × EL-30-2-1	-14.66**	-0.94	0.44**	1.86**	1.31	3.57**
Super Basmati × Basmati-385	4.43**	4.63**	0.51**	1.36*	3.46	3.33**
Super Basmati × DM-25	-8.73**	-6.53**	-0.33**	-2.84**	-6.85**	-5.44**
Super Basmati × EL-30-2-1	4.30**	1.90*	-0.17*	1.47*	3.39	2.10
Shaheen Basmati × Basmati-385	-4.74**	-5.48**	0.05	-1.61*	-6.41**	-4.58**
Shaheen Basmati × DM-25	2.10	1.39	0.50**	-0.35	9.82**	2.50*
Shaheen Basmati × EL-30-2-1	2.64	4.09**	-0.54**	1.96**	-3.40	2.09
S.E.(SCA effects for crosses)	1.40	0.91	0.08	0.63	1.87	1.07

*,** = Significant at 0.05 and 0.01 level of probability, respectively S.E. = Standard Error

Present study could suggest the usefulness of some morpho-physiological traits in the identification of good general combiner parents and hybrids. Sets of various better parents and crosses were adjudged and appropriate breeding methods were suggested for the improvement of grain yield and other desirable traits. Non-additive gene action appeared to control the inheritance of these traits. These findings may play significant role in the development of high yielding Basmati rice varieties through bringing improvement *via* flag leaf area, panicle density, biological yield and harvest index.

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