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Combining ability for yield and quality characters in rice (*Oryza sativa* L.)

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ABSTRACT

Field trials were conducted during wet season 2000 and dry season 2001 to study the effect of cultivars and seed rates on grain yield in wet seeded rice. Among the varieties, mean maximum grain yield was recorded in IET 8887 (2.34 t ha^{-1}) followed by IET 9219 (2.29 t ha^{-1}), IET 8886 (2.26 t ha^{-1}), Rasi (2.24 t ha^{-1}), Vikas (2.22 t ha^{-1}) and IET 9994 (2.19 t ha^{-1}) while the lowest grain yield was recorded in IET-9818 (1.84 t ha^{-1}). Seed rates increased grain yield significantly up to 250 kg ha^{-1} (2.61 t ha^{-1}) but further increase in seed rate did not increase grain yield proportionately. Weed dry matter production reduced significantly up to 300 kg seed ha^{-1} (57.41 g). Significantly maximum weed dry matter was recorded in c.v. IET 9818. IET 8887 and IET 9994 recorded higher net returns of Rs. 810 ha^{-1} and Rs.610 ha^{-1}, respectively, while 250 kg seed ha^{-1} in variety recorded highest net returns of Rs. 1,640 ha^{-1}.

Key words: *Rice, combining ability, quality traits*

The success of any breeding programme depends on the choice of right parents in hybridization programme. Combining ability analysis of the parents and their crosses provide information on the two variance *viz.*, additive and dominance, which are important to decide the parents and crosses to be selected for eventual success and also the appropriate breeding procedures to be followed to select desirable segregant. Hence a study on combining ability of seven lines and four testers was undertaken.

MATERIALS AND METHODS

Seven lines *viz.*, IR 6331-1-B-3R-B-24-3, IR 71895-3R-17-1-2-13, KJT-3-2-67-10-21, MTU 1067, AUR 4, CRAC 2221-67 and CR-WITA 12 and four testers (TRY-1, CO 43, Jaya and HUR-DBS-7) and their twenty eight hybrids were grown in randomized block design during September, 2004 with three replications. For each entry, 20 plants were maintained in each replication with a spacing of 20 cm between rows and 15 cm between plants within a row. Observations were recorded on grain length, grain breadth, grain L/B ratio, kernel length, kernel breadth, kernel L/B ratio and grain yield plant^{-1}. Estimates of combining ability were computed according to Kempthorne (1957).

RESULTS AND DISCUSSION

The analysis of variance for combining ability revealed highly significant differences among the hybrids with respect to all the characters (Table 1) studied. The significance of mean squares due to lines (varieties being used as female parent) and testers (varieties being used as male parent) indicated prevalence of additive variance for most of the characters. The significance of mean squares due to line x tester for all the characters indicate that non-additive variance was important for majority of the characters. The predominance of *sca* variances for all the characters suggested that dominance and epistatic gene interactions were important for controlling these traits, confirming the earlier findings of Satyanarayana *et al*. (2000) and Panwar (2005).

The proportional contribution to the total variance by lines, testers and interaction revealed that the lines and line x tester interaction have contributed more than testers in respect of all the characters (Table 2).

General combining ability (GCA) effects. Analysis of mean performance of the parents and their *gca* effects reveal the *per se* performance of the parents (Table 3). Based on *gca* effects Jaya and CRAC 2221-

Table 1 Analysis of variance for combining ability for seven characters in rice

Source	df	Grain length	Grain breadth	Grain L/B ratio	Kernel length	Kernel breadth	Kernel L/B ratio	Grain yield plant^{-1}
Replication	1	0.0013	0.0415	0.0062	0.0040	0.0155	0.0129	0.1889
Hybrid	27	0.6072**	0.1109**	0.3639**	0.6097**	0.0146*	0.1544**	14.3507**
Line	6	0.4950**	0.0114	0.1200*	0.6624**	0.0212*	0.1650**	18.0648**
Tester	3	0.2233**	0.0001	0.1367*	0.7946**	0.0083	0.0813*	4.2576**
L x T	18	0.8147**	0.0260**	0.2036**	0.0020*	0.0406**	0.0962*	8.1484**
Error	38	0.0277	0.0073	0.0521	0.0320	0.0068	0.0241	0.5864
Estimation of Variance								
GCA		0.0042	0.0019	0.0056	0.0012	0.0002	0.0007	0.3383
SCA		0.2269	0.0231	0.0712	0.2704	0.0070	0.0755	1.8125
GCA/SCA		0.0185	0.0822	0.0786	0.0044	0.0285	0.0092	0.1864

* Significant at 5 per cent level ** Significant at 1 per cent level

Table 2. Contribution of lines, testers and their interaction

Contribution by	Grain length	Grain breadth	Grain L/B ratio	Kernel length	Kernel breadth	Kernel L/B ratio	Grain yield plant^{-1}
Lines (%)	42.22	62.04	59.11	24.75	4.25	15.32	78.62
Testers (%)	4.92	5.74	5.27	12.61	0.72	9.08	1.81
Interaction (L x T) (%)	52.86	32.21	35.62	62.63	95.03	75.60	19.53

Table 3. Mean and general combining ability effects of parents for seven characters in rice

Parents	Grain length	Grain breadth	Grain L/B ratio	Kernel length	Kernel breadth	Kernel L/B ratio	Grain yield plant^{-1}
Lines							
IR 6331-1-B-3R-B-24-3	9.55	2.85	3.30	7.60	2.36	3.15	21.42
	0.65**	-0.36**	0.58**	0.35**	-0.00	0.17**	-0.37
IR 71895-3R-17-1-2-13	10.00	2.76	3.60	7.40	2.25	3.25	23.14
	0.03**	-0.19**	0.39**	-0.30**	-0.03	-0.09	-0.17
KJT-3-2-67-10-21	9.25	2.83	3.60	6.30	2.35	2.60	25.77
	0.18**	0.12**	-0.20*	-0.05	0.00	-0.01	-0.11
MTU 1067	9.70	2.76	3.45	7.45	2.30	3.20	25.12
	-0.05	0.07*	-0.10	-0.03	0.02	-0.03	0.13
AUR 4	8.65	2.83	3.00	6.55	2.10	3.05	22.16
	- 0.55**	0.18**	-0.40**	-0.43**	-0.02	-0.18**	0.06
CRAC 2221-67	9.55	2.65	3.75	7.65	2.15	3.55	30.64
	-0.04	0.11**	-0.11	0.24**	0.01	0.09	0.77**
CR-WITA 12	9.35	2.78	3.45	7.75	2.35	3.25	24.47
	-0.13*	0.07*	-0.15	0.22**	0.02	0.05	-0.31
SE	0.59	0.03	0.08	0.06	0.03	0.05	0.27
Testers							
TRY-1	8.85-0.07	2.84-0.00	3.05-0.02	6.60-0.02	2.15-0.01	3.05-0.01	23.91-1.65**
CO 43	9.50	2.85	3.60	7.75	2.20	3.50	22.32
	0.12**	0.03	-0.07	0.08	0.01	0.02	-1.38**
Jaya	9.60	2.86	3.30	7.85	2.25	3.40	35.25
	0.11*	-0.09**	0.15*	0.21**	-0.01	0.10*	4.20**
HUR-DBS-7	9.25	2.83	3.05	6.85	2.10	3.20	22.16
	-0.16**	0.06**	-0.10	-0.31**	-0.01	-0.13**	-0.99**
SE	0.45	0.02	0.06	0.05	0.02	0.04	0.20

* Significant at 5 per cent level ** Significant at 1 per cent level

Table 4. Specific combining ability effects of hybrids for seven characters in rice

Hybrids	Grain length	Grain breadth	Grain L/B ratio	Kernel length	Kernel breadth	Kernel L/B ratio	Grain yield plant^{-1}
IR 6331-1-B-3R-B-24-3 x TRY-1	0.07	- 0.07	0.33*	- 0.11	- 0.08	0.06	0.36
IR 71895-3R-17-1-2-13 x TRY-1	0.57**	0.01	0.16	0.59**	- 0.06	0.37**	0.06
KJT-3-2-67-10-21 x TRY-1	- 0.25*	- 0.10	- 0.05	- 0.36**	0.07	- 0.26*	0.86
MTU 1067 x TRY-1	0.52**	0.05	0.10	0.53**	0.09	0.11	- 0.66
AUR 4 x TRY-1	- 0.73**	0.24**	- 0.50**	- 0.32*	0.13*	- 0.34**	- 0.74
CRAC 2221-67 x TRY-1	0.26*	- 0.09	0.11	0.30*	- 0.04	0.19	- 0.43
CR-WITA 12 x TRY-1	- 0.45**	- 0.05	- 0.15	- 0.62**	- 0.11	- 0.12	0.55
IR 6331-1-B-3R-B-24-3 x CO 43	0.03	- 0.10	- 0.37*	- 0.12	- 0.08	0.09	- 1.37*
IR 71895-3R-17-1-2-13 x CO 43	0.03	- 0.11	0.26	0.48**	- 0.11	0.35**	0.28
KJT-3-2-67-10-21 x CO 43	0.16	- 0.03	0.15	- 0.37**	0.07	- 0.27*	0.61
MTU 1067 x CO 43	0.18	0.02	0.10	0.52**	0.09	0.09	0.42
AUR 4 x CO 43	- 0.12	- 0.09	0.15	- 0.23	- 0.07	- 0.01	1.15*
CRAC 2221-67 x CO 43	- 0.73**	0.39**	- 0.59**	- 0.76**	0.11	- 0.47**	- 2.72**
CR-WITA 12 x CO 43	0.46**	- 0.08	0.30	0.47**	- 0.01	0.22	1.62**
IR 6331-1-B-3R-B-24-3 x Jaya	- 0.11	0.11	0.00	- 0.05	0.13*	- 0.19	1.98**
IR 71895-3R-17-1-2-13 x Jaya	- 0.76**	0.10	- 0.46**	- 0.80**	0.06	- 0.48**	0.71
KJT-3-2-67-10-21 x Jaya	0.31*	- 0.11	0.23	0.55**	- 0.07	0.35**	- 1.21*
MTU 1067 x Jaya	- 0.46**	0.04	- 0.22	- 0.71**	- 0.09	- 0.19	0.69
AUR 4 x Jaya	0.79**	- 0.02	0.23	0.39**	- 0.11	0.36**	- 0.93
CRAC 2221-67 x Jaya	- 0.02	0.25**	0.29**	0.17*	0.03*	0.10*	1.81*
CR-WITA 12 x Jaya	0.26*	0.14*	- 0.07	0.44**	0.11	0.04	- 2.58**
IR 6331-1-B-3R-B-24-3 x HUR-DBS-7	0.01	0.06	0.05	0.28*	- 0.03	0.04	- 0.97
IR 71895-3R-17-1-2-13 x HUR-DBS-7	0.16	- 0.00	0.03	- 0.28*	0.11	- 0.25*	- 1.06
KJT-3-2-67-10-21 x HUR-DBS-7	- 0.22	0.24**	- 0.33*	0.18	- 0.07	0.18	- 0.26
MTU 1067 x HUR-DBS-7	- 0.24*	- 0.11	0.02	- 0.34*	- 0.09	- 0.01	- 0.45
AUR 4 x HUR-DBS-7	0.06	- 0.13*	0.12	0.16	0.04	- 0.01	0.52
CRAC 2221-67 x HUR-DBS-7	0.50	- 0.05	0.18	0.29*	- 0.03	0.18	1.34**
CR-WITA 12 x HUR-DBS-7	- 0.27*	- 0.01	- 0.08	- 0.29*	0.01	- 0.13	0.41
SE	0.12	0.06	0.16	0.13	0.06	0.11	0.54

* Significant at 5 per cent level ** Significant at 1 per cent level

67 were found to be good general combiners for grain yield plant^{-1}. IR 6331-1-B-3R-B-24-3 was identified as good general combiner for grain length, grain L/B ratio, kernel length and kernel L/B ratio. The crosses involving these parents might produce heterotic hybrids with high mean performance for respective traits.

Specific combining ability (SCA) effects. High *sca* effect results mostly from the dominance and interaction effects existed between the hybridizing parents. In the present study, positive significant *sca* effect for grain yield plant^{-1} was exhibited by 5 crosses *viz.*, AUR 4 x CO 43, CR-WITA 12 x CO 43, IR 6331-1-B-3R-B-24-3 x Jaya, AUR 4 x Jaya and AUR 4 x HUR-DBS-7 (Table 4). Most of the crosses having significant *sca* effects recorded higher *per se* performance. The cross combinations having significant *sca* effects but failed to record high *per se* performance result from parents with low x low *gca* effects. The present findings also indicate that crosses having significant *sca* effects recorded the highest *per se* performance, where either of the parent involved in the combination have high *gca* effect. In addition to grain yield plant^{-1}, the crosses having significant and positive *sca* effect for different traits were CRAC 2221-67 x Jaya for grain breadth, grain L/B ratio, kernel length, kernel breadth and kernel L/B ratio; CR-WITA 12 x CO 43 for grain length and kernel length; IR 6331-1-B-3R-B-24-3 x Jaya for kernel breadth; CRAC 2221-67 x HUR-DBS-7 for kernel length. Among the 27 crosses studied, 5 crosses exhibited positive significant *sca* effects for grain yield plant^{-1}. Out of these 5 cross combination showing significant *sca* effects, the cross CRAC 2221-67 x HUR-DBS-7 involved one parent with high *gca* effects and other having either high or low combining ability effect, indicating additive as well as non-additive genetic actions operating in the *per se* crosses. These results are in conformity with the earlier findings of Peng and Virmani (1990), Hasib *et al*. (2001) and Panwar (2005).

From this study, it was observed that non-additive gene action was important in controlling various characters. The best combiner CRAC 2221-67 and Jaya could be utilized in future breeding programmes. The hybrid CRAC 2221-67 x Jaya, CR-WITA 12 x CO 43, IR 6331-1-B-3R-B-24-3 x Jaya and CRAC 2221-67 x HUR-DBS-7 could be used for exploitation of heterosis for yield and quality traits.

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