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Research Article

Combining ability analysis for yield & yield components in rice (*Oryza sativa* L.)

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Abstract
A line x tester analysis was made in rice with seven female and three male parents to indentify suitable general and specific combiner for breeding programme. Dominant type of gene action for all the 16 characters namely days to 50% flowering, plant height, tiller per plant, panicles per plant, flag leaf length, flag leaf width, panicle length, spikelets per panicle, days to maturity, biological yield per plant, test weight, harvest index, seed yield per plant hulling %, milling % and head rice recovery% was observed. Parents ML-10-29VL and TMO7280 were found as good general combiners for seed yield per plant and most of the yield traits. The cross combinations IR77629-72XIR64, BASMATI370 X CR2703 and sonam X NDR1118 were the best specific combiners for seed yield per plant. Hence these three cross combinations may be used for exploitation of heterosis for yield and yield contributing traits in rice.

Key words
Rice, Line X tester, combining ability.

Introduction

The choice of right parents for hybridization is the base of success of any breeding programme. Combining ability analysis of the parents and their crosses provide information on the two variances 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 selected desirable segregants. Hence, a study on combining ability of seven line and three tester was undertaken.

Materials and method

Seven line *viz*., Basmati370, IR7734-4-03-2-2-1-3, IR77629-72-2-1-3, ML-10-29VL, OP16073, Sonam and TMO7280 and three testers *viz*., CR2703, IR-64 and NDR 118 and their 21 hybrids were grown in randomized block design during June 2013 with three replications. For each entry 10 plants were maintained in each replication with a spacing of 20 cm between rows and 15cm between plants within a row. Observation were recorded on days to 50% flowering, plant height, tillers per plant, panicles per plant ,flag leaf length, flag leaf width, panicle length, spikelets per panicle, days to maturity, biological yield per plant, test weight, harvest index, seed yield per plant, hulling%. Milling% and head rice recovery. Estimates of combining ability were computed according to Kempthorne (1957).

Result and discussion

The analysis of variance for combining ability revealed highly significant differences among the crosses with respect to all the characters (Table 1.)studied. The significance of mean squares due to lines (varieties being used as female parents) and tester (varieties being used as male parents) indicated prevalence of additive variance for most of the characters. The significance of mean square 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 interaction were important for contributing these traits, confirming the ealier findings of Satyanarayana *et. al.* (2000), Panwar (2005) and Saravanan *et. al.* (2006). 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. (Table2.)

*General combining ability effects***:** Analysis of mean performance of the parents and their gca effects reveal that gca is reflective of mean for almost all the characters studies (Table 3.). Based on gca effects ML-10-29VL was found to be good general combiner for seed yield, days to 50% flowering, tillers per plant, panicle per plant, days to maturity, biological yield per plant test weight. TMO 7280 was found good general combiner for grain yield, harvest index, hulling %, and milling%. IR 77629-72-2-1-3 was identified as good general combiner for panicle length and spikelets per panicle.

Specific combining ability: High sca effect result mostly from the dominance and interaction effects existing between the hybridizing parents. In the present study, positive significant sca effect for seed yield per plant was exhibited by four crosses viz., IR77629-72XIR64, BASMATI370 X CR2703,SONAM X NDR 1118 and IR 7734-4-0

X CR2703. 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 seed yield per plant ,the crosses having significant and positive sca effect for different traits were Basmati 370X CR2703 for plant height, IR77629 X IR 64 for panicle length, spikelets per panicle, days to maturity, biological yield per plant, test weight, harvest index, hulling %, milling % and head rice recovery %, sonam XNDR1118 for plant height, tiller per plant , spikelets per panicle, days to maturity and biological yield per plant and IR7734-4-4-0 X CR2703 for plant height, panicle length, harvest index and head rice recovery. Four crosses exhibited positive significant sca effects for seed yield per plant. Out of these four crosses combinations showing significant sca effects only Basmati 370 XCR2703 involved both parents with high gca effects indicating additive gene action. Other three cross combinations *viz*.,IR 77629-72 X IR 64, IR 7734-4-0 XCR 2703 and sonam X NDR 1118 were found one parent with high gca effect and anther with low gca effect, indicating additive as well as non additive genetic action operating in the crosses. The result are in conformity with the earlier findings of Peng and Vesmani (1990), Hasib *et al.* (2001), Panwar(2005), Sabesan (2005), Saravanan *et al.* (2006) and Singh and Babu (2012).

From this study, it was observed that non additive gene action was important in controlling various characters. The best combiner ML-10-29VL and TMO7280 could be utilized in future breeding programmes. The hybrid IR 77629-72 X IR-64, BASMATI 370 X CR2703, SONAM X NDR1118 AND IR 7734-4-0 X CR 2703 could be used for exploitation of heterosis for yield and yield components.

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Table 1. Analysis of variance for combining ability for sixteen characters in rice

Sources of variation	Df	Days to 50% Flowering	Plant Height (cm)	Tiller Per Plant	Panicles/ Plant	Flag Feaf Length (cm)	Flag Leaf Width (cm)	Panicle Length (cm)	Spikelets / Panicle	Days to Maturity	Biological Yield/ Plant	Test Weight	harvest Index	Seed Yield / Plant (g)	Hulling %	Milling %	Head Rice Recovery % (hrr)
Replicates	2.00	3.92	5.17	1.76	8.21	0.69	0.01	2.69	0.93	8.14	3.00	2.39	2.99	1.70	7.76	0.19	3.83
Crosses	20.00	47.58**	379.99**	11.51**	10.34**	49.21**	0.10**	17.27**	6219.77**	49.44**	67.24**	202.81**	16.93**	35.55**	75.74**	76.13**	75.50**
Line Effect	6.00	54.11	339.09	13.32	12.94	18.71	0.17	14.02	4656.15	34.48	72.68	282.48	12.81	47.57	53.74	70.93	79.92
Tester Effect	2.00	110.54	325.79	7.67	19.64	150.58	0.12	4.60	5649.04	61.48	55.19	68.97	9.24	13.28	112.19	37.76	24.87
Line * Tester Eff.	12.00	33.82**	409.47**	11.25**	7.49**	47.56**	0.07**	21.00**	7096.71**	54.92**	66.52**	185.27**	20.27**	33.25**	80.67**	85.13**	81.72**
Error	40.00	5.77	2.18	0.91	1.09	3.37	0.01	1.56	0.81	1.39	1.92	6.19	0.83	0.98	2.31	1.77	2.06
Total	62.00	19.20	124.15	4.36	4.30	18.07	0.04	6.67	2006.93	17.11	23.02	69.49	6.09	12.15	26.18	25.71	25.81
GCA	4.96	22.04	0.64	0.94	5.43	0.01	0.53	343.44	4.96	3.07	4.14	0.67	11.28	1.96	5.37	3.48	3.36
SCA	8.62	135.88	3.42	2.04	14.81	0.02	6.53	2365.25	8.62	17.64	21.54	6.44	59.58	10.76	26.08	26.66	26.60
GCA/SCA																	

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

Table 2. Contribution of lines, testers and their interaction

Sources of variation	df	Days to 50% Flowering	Plant Height (cm)	Tiller Per Plant	Panicles/ Plant	Flag Feaf Length (cm)	Flag Leaf Width (cm)	Panicle Length (cm)	Spikelets / Panicle	Days to Maturity	Biological Yield/ Plant	Test Weight	harvest Index	Seed Yield / Plant (g)	Hulling %	Milling %	Head Rice Recovery % (hrr)
Line	34.12	26.77	34.72	37.55	11.41	49.22	24.36	22.46	22.46	20.92	34.43	22.69	41.79	40.14	21.28	27.95	31.76
Tester	23.23	8.57	667	19.00	30.60	11.27	2.66	9.08	9.08	12.43	8.21	5.46	3.40	3.74	14.81	4.96	3.29
Line x Tester	42.65	64.66	58.61	43.46	57.99	39.51	72.98	68.46	68.46	66.65	59.36	71.85	54.81	56.12	63.90	67.09	64.95

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

Table 3. General combining ability effects of parents for sixteen characters in rice

Parents	Basmati 370	IR7734-4-03-2-2-1-3	IR77629-72-2-1-3	ML-10-29VL	OP16073	sonam	TM07280	CR2703	IR-64	NDRI118
Days to 50% Flowering	2.00*	1.56	-1.78	-4.78**	1.33	0.33	1.33	1.56*	1.08	-2.63**
Plant Height (cm)	1.82**	8.22**	3.33**	-7.40**	-0.81	-8.71**	3.56**	4.26**	-3.50**	-0.76*
Tiller Per Plant	-0.95**	-1.70**	1.13**	1.93**	-0.22	-0.16	-0.05	-0.22	-0.47*	0.68**
Panicles/ Plant	-1.00*	-1.76**	0.71	1.67**	-0.19	-0.43	1.00*	-0.56*	-0.56*	1.12**
Flag Feaf Length (cm)	0.65	-0.21	1.67**	-1.87**	0.73	1.06	-2.02**	-0.63	2.94**	-2.31**
Flag Leaf Width (cm)	0.21**	-0.01	-0.19**	0.13**	-0.03	-0.12**	0	-0.01	-0.07**	0.08**
Panicle Length (cm)	-0.76	0.82*	2.41**	-1.27**	-0.37	-0.73	-0.09	0.53*	-0.36	-0.17
Spikelets/ Panicle	4.56**	-4.51**	44.06**	-10.00**	-25.32**	-17.48**	8.69**	-17.29**	15.34**	1.95**
Days to Maturity	0.29	1.62**	1.95**	-3.71**	1.29**	-0.71	-0.71	-1.24**	1.95**	-0.71*
Biologicl Yield/ Plant	3.10**	-0.02	0.98*	3.21**	-4.79**	-2.13**	-0.35	1.43**	0.33	-1.76**
Test Weight	0.84*	-0.37	-1.48**	1.56**	-0.73*	-1.04**	1.21**	0.64**	0.04	-0.68**
harvest Index	-0.95	-6.36**	-2.06*	0.66	1.97*	-4.23**	10.98**	1.1	-2.09**	0.99
Seed Yield/ Plant (g)	0.81*	-2.33**	-0.43	1.38**	-1.09**	-2.40**	4.07**	0.87**	-0.69**	-0.19
Hulling %	-0.4	-2.17**	-1.40*	1.94**	2.27**	-3.29**	3.05**	2.57**	-1.90**	-0.67
Milling %	0.44	-2.33**	-0.67	1.33**	2.56**	-4.67**	3.33**	1.48**	-1.14**	-0.33
Head Rice Recovery % (hrr)	0.63	-1.92**	0.19	1.75**	3.19**	-5.70**	1.86**	0.70*	-1.25**	0.56

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

	Days to 50% Flowering	Plant Height (cm)	Tiller Per Plant	Panicles/ Plant	Flag Feaf Length (cm)	Flag Leaf Width (cm)	Panicle Length (cm)	Spikelets/ Panicle
Basmati 37*CR2703	0	-17.25**	-0.48	0.63	1.17	-0.01	-1.25	-24.26**
Basmati 37*IR-64	-6.19**	-0.02	-1.17*	-1.81*	-3.35**	0.08	-1.29	-41.90**
Basmati 37*NDRI118	6.19**	17.27**	1.65**	1.18	2.19*	-0.07	2.54**	66.16**
IR7734-4-0*CR2703	-1.89	10.11**	0.67	0.66	-2.55*	-0.19**	2.33**	-24.60**
IR7734-4-0*IR-64	4.59**	3.91**	1.09	0.46	-1.02	0.07	-3.12**	6.57**
IR7734-4-0*NDRI118	-2.7	-14.03**	-1.76**	-1.12	3.57**	0.12	0.78	18.04**
IR77629-72*CR2703	0.78	-5.36**	1.20*	0.39	-0.57	0.06	-3.24**	-14.15**
IR77629-72*IR-64	-0.08	0.27	0.33	0.9	-3.88**	0.04	2.04**	23.05**
IR77629-72*NDRI118	-0.7	5.09**	-1.53*	-1.29	4.45**	-0.1	1.21	-8.91**
ML-10-29VL*CR2703	1.11	2.17**	1.41*	0.09	2.35*	-0.1	-0.54	-26.32**
ML-10-29VL*IR-64	1.92	-4.13**	-2.55**	-2.28**	0.02	-0.01	1.18	-16.79**
ML-10-29VL*NDRI118	-3.03	1.96*	1.14	2.19**	-2.37*	0.11	-0.64	43.11**
OP16073*CR2703	1	1.58*	0.39	0.08	-3.13**	-0.06	-1.61*	5.93**
OP16073*IR-64	-2.19	-10.85**	1.62**	1.71*	3.07**	-0.14*	0.37	46.47**
OP16073*NDRI118	1.19	9.27**	-2.01**	-1.80*	0.06	0.21**	1.24	-52.39**
sonam*CR2703	-0.67	3.61**	-1.87**	-0.91	-0.2	0.09	4.10**	36.37**
sonam*IR-64	0.48	-0.35	-0.82	-0.14	6.17**	-0.06	-1.28	-45.44**
sonam*NDRI118	0.19	-3.26**	2.69**	1.05	-5.97**	-0.04	-2.82**	9.07**
TM07280*CR2703	-0.33	5.14**	-1.32*	-0.94	2.94**	0.20**	0.21	47.04**
TM07280*IR-64	1.48	11.17**	1.50*	1.16	-1.01	0.02	2.09**	28.04**
TM07280*NDRI118	-1.14	-16.31**	-0.18	-0.22	-1.92	-0.23**	-2.30**	-75.09**

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

Table 4. Contd

	Days to Maturity	Biologicl Yield/ Plant	Test Weight	harvest Index	Seed Yield/ Plant (g)	Hulling %	Milling %	Head Rice Recovery % (hrr)
Basmati 37*CR2703	1.57	1.24	-0.21	6.60**	3.35**	-2.79**	-2.25*	-0.59
Basmati 37*IR-64	-5.29**	1.67*	1.89**	-2.87	-0.86	3.68**	2.03*	2.37**
Basmati 37*NDRI118	3.71**	-2.90**	-1.68**	-3.73*	-2.48**	-0.89	0.22	-1.78*
IR7734-4-0*CR2703	0.57	0.02	-0.03	6.39**	2.45**	0.65	1.52	1.63*
IR7734-4-0*IR-64	5.38**	-0.56	0.63	3.59*	1.12	-3.21**	-2.52**	-2.75**
IR7734-4-0*NDRI118	-5.95**	0.54	-0.6	-9.98**	-3.57**	2.56**	1	1.11
IR77629-72*CR2703	-3.43**	0.35	-1.85**	-9.96**	-3.92**	1.54	0.19	-1.14
IR77629-72*IR-64	3.71**	5.11**	3.58**	8.25**	5.22**	4.68**	5.81**	5.48**
IR77629-72*NDRI118	-0.29	-5.46**	-1.73**	1.71	-1.31*	-6.22**	-6.00**	-4.33**
ML-10-29VL*CR2703	0.24	3.46**	4.18**	-5.87**	-1.28*	2.54**	0.86	1.3
ML-10-29VL*IR-64	-2.62**	-3.44**	-3.51**	-6.55**	-3.68**	-8.65**	-9.52**	-9.75**
ML-10-29VL*NDRI118	2.38**	-0.02	-0.68	12.41**	4.95	6.11**	8.67**	8.44**
OP16073*CR2703	1.57	5.13**	-0.54	-4.64**	0.26	-3.79**	-3.70**	-3.81**
OP16073*IR-64	3.71**	-2.78**	-0.36	2.93	0.15	3.02**	3.59**	4.14**
OP16073*NDRI118	-5.29**	-2.35**	0.91	1.71	-0.41	0.78	0.11	-0.33
sonam*CR2703	-0.43	-8.21**	0.9	5.98**	-0.72	5.43**	4.86**	4.08**
sonam*IR-64	-2.95**	1.22	-0.99	-6.43**	-1.86**	-3.76**	-3.19**	-3.63**
sonam*NDRI118	3.38**	6.98**	0.09	0.45	2.57**	-1.67	-1.67	-0.44
TM07280*CR2703	-0.10*	-1.98*	-2.45**	1.5	-0.14	-3.57**	-1.48	-1.48
TM07280*IR-64	-1.95*	-1.22	-1.25*	1.08	-0.1	4.24	3.81**	4.14**
TM07280*NDRI118	2.05*	3.21	3.70**	-2.58	0.24	-0.67	-2.33**	-2.67**