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Research Article

Combining ability for yield & yield contributing characters in rice (O*ryza sativa* L.)

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Abstract:
A line X tester analysis was made in rice with seven ovule parents and four pollinator parents so as to identify suitable general and specific combiner for breeding program. Dominant type of gene action for all the six traits namely, days to 50 percent flowering, plant height, number of productive tillers per plant, number of grains per panicle, hundred grain weight and grain yield per plant was observed. Parents JAYA and CRAC 2221-67 were good general combiners for grain yield per plant and most of the yield traits. The cross combinations CRAC2221-67 x JAYA and IR6331-1-B-3R-B-24-3 X JAYA were the best specific combiners for grain yield per plant. Hence, these two cross combinations may be used for exploitation of heterosis for yield and yield contributing traits in rice.

Key words:
Rice, combining ability, Line x tester analysis.

Introduction

The success of any breeding programme depends on the choice of right parents for 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 segregants. Hence, a study on combining ability of seven lines and four testers was undertaken.

Material and Methods

Seven lines viz., IR6331-1-B-3R-B-24-3, IR 71895-3R-17-1-2-13, KJT-3-2-67-10-21, MTU 1067, AUR4, 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 two replications. For each entry, 20 plants were maintained in each replication with a spacing of 20 cm between rows and 15cm between plants with in a row. Observations were recorded on days to 50 per cent flowering, plant height, number of productive tillers per plant, number of grains per panicle, hundred grain weight and grain yield per plant. 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

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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), 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, except days to 50 per cent flowering and grain yield per plant (Table 2).

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 studied (Table 3). Based on gca effects JAYA and CRAC 2221-67 were found to be good general combiners for grain yield per plant. IR 71895-3R-17-1-2-13 was found to be good general combiner for plant height, number of productive tillers per plant and number of grains per panicle. CO43 was identified as good general combiner for days to 50 per cent flowering.

Specific combining ability effects

High sca effect results mostly from the dominance and interaction effects existing between the hybridizing parents. In the present study, positive significant sca effect for grain yield per plant was exhibited by 5 crosses viz., AUR 4 XCO43, CR-WITA12 X CO43, IR 6331-1-B-3R-B-24-3 X JAYA, CRAC2221-67 x JAYA and CRAC 2221-67 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 per plant, the crosses having significant and positive sca effect for different traits were CRAC 2221-67X JAYA for plant height, number of grains per panicle, and hundred grain weight; IR6331-1-B-3R-B-24-3 x JAYA for days to 50 percent flowering, positive sca effect for plant height, hundred grain weight and grain yield per plant, also CRAC2221-67 x Jaya for plant height, number of grains per panicle, hundred grain weight and grain yield per plant. Among the 28 hybrids, 5 crosses exhibited positive significant sca effects for grain yield per plant. 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 low combining ability effect, indicating additive as well as non-additive genetic actions operating in the crosses. These results are in conformity with the earlier findings of Peng and Virmani (1990), Hasib et al., (2001), Panwar (2005), Sabesan (2005) and Saravanan et al., (2006).

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 12X Co43, 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 yield contributing traits.

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

Source	df	Days to 50 percent flowering	Plant height	Number of productive tillers per plant	Number of grains per panicle	Hundred grain weight	Grain yield per plant
Replication	1	4.6410	3.3141	7.1390	30.8301	0.0006	0.1889
Hybrid	27	50.3229**	43.8132**	8.5516**	274.7002**	0.1006**	14.3507**
Line	6	50.9518**	48.8724**	3.9095**	142.0293**	0.0302**	18.0648**
Tester	3	161.8333**	40.9870**	19.9133**	27.5469	0.0541**	4.2576**
L x T	18	108.0547**	867.9219**	0.6758	987.4688**	0.0015*	8.1484**
Error	38	1.2068	1.9785	0.5363	30.7267	0.0007	0.5864
Estimation of variance							
GCA		1.0983	0.3473	0.1306	2.5472	0.0013	0.3380
SCA		8.0830	15.7084	2.0483	83.7785	0.0298	1.8125
GCA/SCA		0.1358	0.0221	0.0637	0.0304	0.0436	0.1864

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

Table 2. Contribution of lines, testers and their interaction

Contribution	Days to 50 percent flowering	Plant height	Number of productive tillers per plant	Number of grains per panicle	Hundred grain weight	Grain yield per plant
Lines (%)	9.03	35.63	57.54	41.69	56.89	1.81
Testers (%)	67.95	13.55	6.35	10.18	3.12	78.62
Interaction (L x T) (%)	23.02	50.81	36.12	48.12	39.99	19.56

Table 3. Mean and general combining ability effects of parents for 6 characters in rice

Parents	Days to 50 per cent flowering	Plant height (cm)	Number of productive tillers per plant	Number of grains per panicle	Hundred grain weight (g)	Grain yield per plant (g)
Lines						
IR6331-1-B-3R-B-24-3	95.50 1.07**	92.60 -0.89	14.00 0.14	138.30 5.86**	2.41 0.27**	21.42 -0.37
IR71895-3R-17-1-2-13	93.50 -1.68**	99.00 5.78**	14.10 1.46**	154.25 10.12**	2.20 -0.30**	23.14 -0.17
KJT-3-2-67-10-21	85.50 0.95*	100.20 0.76	12.70 1.76**	161.10 6.33**	2.41 -0.01	25.77 -0.11
MTU 1067	89.00 2.20**	105.70 1.21*	10.40 -0.14	148.15 -0.64	2.59 0.08**	25.12 0.13
AUR 4	95.00 0.57	100.50 -2.77**	12.30 0.79**	156.30 -4.93*	2.40 0.11**	22.16 0.06
CRAC 2221-67	83.00 -2.05**	100.70 -1.59**	11.10 -0.84**	146.60 -3.64	2.49 -0.08**	24.64 0.77**
CR-WITA 12	86.00 -1.05**	108.00 -2.49**	12.00 -3.16**	140.15 -13.10**	2.32 -0.07**	30.47 -0.31
SE	0.39	0.49	0.26	1.96	0.01	0.27
Testers						
TRY-1	107.00 6.93**	94.40 2.55**	16.90 0.88**	137.20 3.14*	2.21 -0.02**	23.91 -1.65**
CO43	87.00 -3.43**	87.40 0.50	13.50 -0.35	134.40 -1.98	2.45 0.03**	22.32 -1.38**
JAYA	94.00 -1.57**	85.60 -1.35**	10.10 -0.22	139.15 3.86*	2.61 -0.05**	35.25 4.02**
HUR-DBS-7	89.00 -1.93**	84.20 -1.70**	10.50 -0.32	130.60 -5.03**	2.41 0.04**	22.16 -0.99**
SE	0.29	0.38	0.19	1.48	0.01	0.20

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

Table 4. Mean and specific combining ability effects of hybrids for six characters in rice

Hybrids	Mean/ sca	Days to 50 per cent flowering	Plant height (cm)	Number of productive tillers per plant	Number of grains per panicle	Hundred grain weight (g)	Grain yield per plant (g)
IR6331-1-B-3R-B-24-3 x TRY -1	Mean	102.50	105.60	16.40	167.10	2.74	33.86
	sca	4.07**	-5.12**	0.89	6.86	0.03	0.36
IR71895-3R-17-1-2-13 x TRY -1	Mean	93.00	114.70	17.90	175.40	2.04	33.76
	sca	-2.68**	-2.70**	1.07*	10.89**	-0.10**	0.06
KJT-3-2-67-10-21 x TRY -1	Mean	96.00	115.80	16.20	162.50	2.45	34.63
	sca	-2.30**	3.43**	-0.93	1.78	0.03	0.86
MTU 1067 x TRY -1	Mean	101.50	119.40	14.90	152.90	2.65	33.35
	sca	1.95*	6.58**	-0.33	-0.84	0.14**	-0.66
AUR 4 x TRY -1	Mean	101.00	111.50	16.00	143.95	2.53	33.19
	sca	3.07**	2.65*	-0.16	-5.51	-0.02	-0.74
CRAC 2221-67 x TRY -1	Mean	93.00	106.70	13.30	139.35	2.23	34.21
	sca	2.30**	-3.32**	-1.23*	-11.39**	-0.13**	-0.43
CR-WITA 12 x TRY -1	Mean	94.50	107.60	12.90	139.50	2.41	34.12
	sca	-1.80*	-1.52	0.69	-1.78	0.04*	0.55
IR6331-1-B-3R-B-24-3 x CO43	Mean	85.00	107.60	14.80	138.40	2.73	32.42
	sca	-3.07**	-1.08	0.52	-16.72**	-0.03	-1.37*
IR71895-3R-17-1-2-13 x CO43	Mean	90.50	117.70	16.30	147.95	2.04	34.27
	sca	5.18**	2.35*	0.70	-11.44**	-0.15**	0.28
KJT-3-2-67-10-21 x CO43	Mean	91.00	108.90	15.20	160.10	2.37	34.64
	sca	3.05**	-1.43	-0.70	4.50	-0.10**	0.61
MTU 1067 X CO43	Mean	85.50	114.20	15.70	156.60	2.75	34.70
	sca	-3.70**	3.42**	1.70**	7.98*	0.19**	0.42
AUR 4 X CO43	Mean	86.50	104.40	13.60	156.35	2.73	35.36
	sca	-1.07	-2.40*	-1.33*	12.01**	0.13**	1.15*
CRAC 2221-67 x CO43	Mean	83.50	109.40	12.50	148.75	2.30	32.20
	sca	1.45	1.42	-0.80	3.13	-0.11**	-2.72**
CR-WITA 12 x CO43	Mean	87.00	104.80	10.90	136.70	2.49	35.47
	sca	1.05	-2.28*	-0.08	0.54	0.07**	1.62**
IR6331-1-B-3R-B-24-3 x JAYA	Mean	91.50	110.10	13.50	164.70	2.80	41.16
	sca	-1.57*	3.28**	-0.91	3.74	0.13**	1.98**
IR71895-3R-17-1-2-13 x JAYA	Mean	87.00	113.20	13.80	151.40	2.12	40.09
	sca	0.18	-0.30	-1.93**	-13.82**	0.02	0.71
KJT-3-2-67-10-21 x JAYA	Mean	87.50	104.70	17.70	168.30	2.39	28.23
	sca	-2.30**	-3.77**	1.67**	6.87	0.00	-1.21*
MTU 1067 x JAYA	Mean	90.50	108.80	16.00	151.20	2.58	40.37
	sca	0.55	-0.12	1.87**	-3.26	0.10**	0.69
AUR 4 x JAYA	Mean	89.00	102.50	14.90	145.65	2.45	38.68
	sca	-0.43	-2.45*	-0.16	-4.52	-0.07**	-0.93
CRAC 2221-67 x JAYA	Mean	87.50	106.40	13.10	160.30	2.25	41.65
	sca	-0.70*	0.28*	-0.33	8.84*	0.07**	1.81*
CR-WITA 12 x JAYA	Mean	89.00	108.30	10.90	144.15	2.23	36.66
	sca	1.20	3.08**	-0.21	2.15	-0.11**	-2.58**
IR6331-1-B-3R-B-24-3 x HUR-DBS-7	Mean	87.00	109.40	13.80	158.20	2.64	33.21
	sca	-2.57**	2.92**	-0.51	6.13	-0.13**	-0.97
IR71895-3R-17-1-2-13 x HUR-DBS-7	Mean	84.50	11.80	15.80	170.70	2.42	33.32
	sca	-2.32**	0.65	0.17	14.36**	0.22**	-1.06
KJT-3-2-67-10-21 x HUR-DBS-7	Mean	91.00	109.90	15.90	139.40	2.56	34.17
	sca	1.55	1.77	-0.03	-13.15**	0.08**	-0.26
MTU 1067 x HUR-DBS-7	Mean	93.00	98.70	10.80	141.70	2.15	34.22
	sca	2.30**	-9.88**	-3.23**	-3.87	-0.42**	-0.45
AUR 4 x HUR-DBS-7	Mean	87.50	106.80	16.60	139.30	2.56	35.12
	sca	-1.57*	2.20*	1.64**	-1.99	-0.05*	0.52
CRAC 2221-67 x HUR-DBS-7	Mean	89.50	107.40	15.70	142.00	2.72	37.12
	sca	3.05**	1.62	2.37**	-0.57	0.30**	1.34**
CR-WITA 12 x HUR-DBS-7	Mean	87.00	105.60	10.60	132.20	2.43	34.64
	sca	-0.45	0.72	-0.41	-0.91	-0.00	0.41
SE		0.78	0.99	0.52	3.92	0.02	0.54

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