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Research Article

Identification of parents and hybrids for yield and its components using line x tester analysis in rice (*Oryza sativa* L.)

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Abstract

Combining ability analysis for yield and its component traits was carried out in rice through line x tester analysis of 20 hybrids developed by crossing 5 females with 4 male lines along with parents and checks at Agricultural Rice Research Station, Nellore, ANGRAU, AP during *kharif* 2014. The estimates of *gca* effects indicated that, among females, BPT 5204 and among males IR 64, were good general combiners for grain yield per plant. High *sca* effects were observed in the crosses, WGL 48684 x IR 36 and RNR 2465 x IR 36 and they were found to be best combinations for grain yield per plant.

Keywords

Rice, combining ability, line x tester, grain yield per plant

Introduction

Rice (*Oryza sativa* L.) is the world's most important food crop providing more than 20% caloric intake for over 3.5 billion people. The demand of rice continues to rise because of increase in population and improvement in living standards. A yield plateau is felt and there is no further increase in productivity although scope for horizontal growth is quite impossible. Reorientation of breeding methodologies is therefore a perquisite where genetic analysis of morpho-agronomic and other quantitative traits on systematic lines can be devised. Choice of suitable parents is of paramount importance since *per se* performance of parents is not always a true indicator of its combining ability in hybrid combination (Sharma and Mani, 2008). The knowledge of combining ability is useful to assess nicking ability among genotypes and at the same time elucidate the nature and magnitude of gene actions involved. The combining ability analysis gives an indication of the variance due to GCA and SCA which represents a relative measure of additive and non-additive gene actions respectively. Breeders use these variance components to measure the gene action and to assess the genetic potentialities of parent in hybrid combinations. Line x tester (Kempthorne, 1957) matting design provide reliable information about the general and specific combining ability (*gca* and *sca*) of parents and their cross combinations and are helpful in estimating various types of gene actions within affordable resources.

Materials and Methods

The experimental materials used for the present investigation consisted of F_1 hybrids of 20 crosses developed by crossing five lines/genotypes of rice *viz*., BPT 5204, MTU 1010, WGL 48684, RNR 2465 and JGL 11118 with four testers *viz*., NLR 34449, NLR 145, IR 36 and IR 64. All the lines used as female parents were crossed to each of the testers by hand pollination during kharif, 2014. The F_1's (20 hybrids along with parental lines (lines (5) + testers (4)) were evaluated in RBD with three replications at Agricultural Research Station, Nellore. In each replication entries (F_1's and parents) were grown in four rows of 2 m length with spacing of 20 cm X 15 cm transplanted as single seedling/hill. The data was recorded from each cross/genotype in each replication for 11 yield traits *viz.* days to 50% flowering, days to maturity, plant height (cm), effective bearing tillers (EBT's) per plant, panicle length (cm), number of filled grains per panicle, number of unfilled grains per panicle, SPAD Chlorophyll Meter Readings (SCMR), harvest Index (%), test weight (g) and grain yield (g/plant). All the traits were studied on individual plant basis except days to 50% flowering and days to maturity which were recorded on plot basis. All the recommended agronomic and plant protection practices were uniformly applied throughout the crop growth period. The data were subjected to the statistical analysis for analysis of variance as per Panse and Sukhatme (1967) and line x tester analysis as per Kempthorne (1957).

Result and Discussion

Analysis of variance for combining ability (Table 1) revealed that mean squares due to females (lines) differed significantly for most of the traits except plant height, panicle length, SCMR and harvest index. Whereas the testers differed

significantly for days to 50% flowering, days to maturity, plant height, filled grains per panicle, test weight and grain yield.
Partitioning of combining ability variances into fixable additive and non-fixable dominance variance indicated that the nonadditive gene action played a significant role in the inheritance of most of the traits. In the present study, the magnitude of sca variance was higher than gca variance for all the biometrical characters except in unfilled grains per panicle and harvest index indicating the preponderance of non-additive gene action in the expression of these traits. But for the trait, unfilled grains per panicle the ratio was near to unity indicating the presence of additive gene action played a prominent role in the inheritance of the trait. To exploit the non-additive gene action of these traits, heterosis breeding or hybridization followed by selection in later generations is recommended for the improvement of these traits in rice. These results were in agreement with the earlier findings of Bineeta and Lal (2015) for grain yield, Siva (2016) for days to 50% flowering, days to maturity, plant height and harvest index, Sathya and Jebaraj (2015) for effective bearing tillers per plant, panicle length, number of filled grains per panicle and SCMR, Jhansi Rani and Satyanarayana (2015) for test weight.

The proportional contribution of lines, testers and line x tester interaction to total variance are presented in table 2. The per cent contribution towards the total variance was maximum due to the interaction of lines and testers for the traits, plant height (80.27), EBT's per plant (78.95), SCMR (75.34), panicle length (58.68), number of filled grains per panicle (48.86), grain yield per plant (48.16). The maximum contribution of lines alone towards the total variance was observed for number of unfilled grains per panicle (61.77), test weight (60.93), harvest index (47.50), days to flowering (46.15) and days to maturity (44.81).

Significant *gca* effect for grain yield per plant was reported in the line BPT 5204 (8.28) and the tester IR 64 (2.09) and hence, considered as good general combiners, similarly out of 20 crosses studied, three crosses *viz*., WGL 48684 x IR 36 (10.12) (L^+xL^+) followed by RNR 2465 x NLR 145 (7.61) ($L^+x\ L^-$) and RNR 2465 x IR 64 (5.88) (L^+xH^+) exhibited highest *sca* effects in desirable direction. The superiority of the cross having low *gca* parents may be due to high nicking ability of those parents. Therefore, it was evident that heterotic hybrids could be produced even by low general combining parents and one can include some low combiners as well in the hybridization programme. The estimates of *gca* effects revealed that, the line JGL 11118 recorded significant *gca* effects in desirable direction for the traits *viz*., days to 50 % flowering, days to maturity, SCMR and harvest index. Whereas, the line RNR 2465 for days to maturity, panicle length, test weight. Among the testers NLR 34449 recorded significant *gca* effects for days to 50% flowering, days to maturity, number of unfilled grains per panicle, test weight. While, the tester IR 64 for grain yield and harvest index. Therefore crosses involving these parents might produce heterotic hybrids with high mean performance and further these lines and testers can be utilized in improvement of the respective traits in breeding programmes.

Among the twenty crosses tested for specific combining ability for eleven different characters, none of the crosses exhibited significant *sca* for all the characters. Each cross showed significant effects for one or more characters only. BPT 5204 x NLR 34449 found to be best for earliness, BPT 5204 x IR 36 for short stature, MTU1010 x NLR 34449 for number of filled grains per panicle and test weight (negative), MTU 1010 x IR 36 for EBT's /plant, JGL 11118 x NLR 145 for SCMR and number of filled grains per panicle, JGL 11118 x IR 36 for panicle length; WGL 48684 x IR 36 and RNR 2465x IR 36 for grain yield. These crosses could be used for isolating superior genotypes from segregating generation for the respective characters based on the objective of the study.

In majority of the crosses, significant sca effects were resulted from good and poor general combiners, indicating additive x dominance type of gene interaction involved in the expression of characters. However, some crosses involving low x low general combiners showed high *sca* effects, suggesting that epistatic gene action, may be due to genetic diversity in the form of heterozygous loci. Very few crosses having high x high general combiners showed high *sca* effects indicating the predominance of additive x additive type of gene action. Similar results were reported by Singh *et al.* (2007).

In crosses, where high x high general combiners were involved for high *sca* effects, they can be utilized for yield improvement through single plant selection in segregating generations. But in the crosses showing high *sca* effects due to high x low general combiners, simple pedigree method of breeding would not be effective to improve the characters. Population improvement *i.e.*, mass selection with concurrent random mating in early segregating generation (Redden and Jensen, 1974) could be a perspective breeding procedure for yield improvement in rice. The crosses showing high *sca* effects involving low x low general combiners could be exploited for heterosis breeding programme.

References

Bineeta, D and Lal, G.M. 2015. Combining ability analysis for yield and yield components in rice (*Oryza sativa* L.). Electronic Journal of Plant Breeding. **6** (2): 360-365.

Jhansi Rani, P and Satyanarayana, P.V. 2015. Studies on combining ability analysis of traits related to grain number and grain weight for yield enhancement in rice (*Oryza sativa* L.). International Journal of Tropical Agriculture. **33** (2): 723-728.

Kempthorne O. 1957.An introduction to genetic statistics. JohnWiley and Sons Inc., New York.

Panse, V.G. and Sukhatme, P.V. (1967). Statistical methods for agricultural workers. Indian Council of Agricultural Research, New Delhi. pp 381.

Redden, R.J and Jensen, N.E.1974. Mass selection and mating systems in cereals. Crop Science.**14**:345-350.

Sathya, R and Jebaraj, S. 2015. Evaluation of aerobic hybrid analysis of combining ability in three line hybrids in Rice (*Oryza sativa* L.) under aerobic conditions. African Journal of Agricultural Research. **10** (18): 1971-1981.

Sharma, R.K and Mani, S.C.2008. Analysis of gene action and combining ability for yield and its components in rice (*Oryza sativa* L.). Oryza.**42**(2):94-97.

Singh, N.K., Anand Kumar and Ramesh Kumar. 2007. Combining ability for yield and yield components in rice. Oryza. **44**(2):156-159.

Siva, M. 2016. Genetic analysis of grain yield and physiological attributes in Rice (*Oryza sativa* L.). M.Sc. Thesis Submitted to Acharya N.G. Ranga Agricultural University Guntur

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Table 1. Analysis of variance for combining ability for yield and yield component traits in rice (*Oryza sativa* L.)

Source of variation	d.f	DFF	DM	PH (cm)	EBTs	PL (cm)	FG/P	UFG/P	SCMR	HI (%)	TW (g)	GY /P(g)
Replicates	1	0.28	1.40	4.52	2.31	0.17	114.52	1.79	2.78	6.69	0.21	26.76
Treatments	28	64.60**	66.66**	42.13**	14.74**	5.90*	1019.96**	33.62**	11.57 **	70.58**	25.21**	137.77**
Parents	8	59.85**	63.85**	25.22**	2.80	5.48	1220.78**	38.37**	8.78 *	25.72*	41.48**	34.67**
Parents (Line)	4	66.00**	68.90**	11.18	5.10*	5.69	1480.54**	62.52**	4.94	18.34	26.52**	33.41**
Parents (Testers)	3	70.46**	75.79**	40.54**	0.67	5.38	660.73**	11.82	7.97	11.60	43.02**	42.37**
Parents (L vs T)	1	3.40	7.80	35.41*	0.00	4.95	1861.86**	21.41	26.51 **	97.55**	96.68**	16.56
Parents vs Crosses	1	263.95**	249.83**	0.56	188.57**	10.70*	2211.31**	2.25	67.80 **	945.07**	48.15**	1610.39**
Crosses	19	56.11**	58.20**	51.44**	10.62**	5.83*	872.71**	33.27**	9.79 **	43.45**	17.15**	103.68**
Line Effect	4	123.00*	123.88*	29.47	9.46	8.43	2015.82	97.62**	6.44	98.02	49.63**	229.71
Tester Effect	3	76.47	68.82	24.99	1.54	4.01	139.07	34.84	6.70	48.40	6.53	34.14
Line * Tester Eff.	12	28.72**	33.66**	65.37**	13.27**	5.41*	675.07**	11.43	11.68 **	24.02*	8.98**	79.06**
Error	28	5.95	4.54	6.08	1.61	2.49	104.09	7.50	3.29	10.99	0.22	7.93
Total	57	34.66	35.00	23.76	8.07	4.13	554.17	20.23	7.35	40.19	12.49	72.05

** Significant at 1% * Significant at 5%

DFF: Days to 50% flowering, DM: Days to Maturity, PH: Plant Height, EBTs: Effective Bearing Tillers per plant, PL: Panicle Length, FG/P: Number of Filled Grains per panicle, UFG/P: Number of Unfilled Grains per Panicle, SCMR: SPAD Chlorophyll Meter Readings, HI: Harvest Index, TW: Test weight, GY/P: Grain Yield/Plant (g)

Table 2. Estimates of genetic components of variance and proportional contribution of lines, testers and line x tester interactions to total variance for yield and yield attributes in rice (*Oryza sativa* L.)

Source of variance	DFF	DM	PH (cm)	EBTs	PL (cm)	FG/P	UFG/P	SCMR	HI (%)	TW (g)	GY /P(g)
gca	10.42	10.20	2.35	0.43	0.41	108.15	6.53	0.36	6.91	3.10	13.78
sca	11.38	14.56	29.65	5.83	1.46	285.49	1.97	4.19	6.52	4.38	35.56
2*gca*/2*gca*+*sca*	0.65	0.58	0.14	0.13	0.36	0.43	0.87	0.15	0.68	0.59	0.44
Contribution (%)											
Lines	46.15	44.81	12.06	18.76	30.46	48.63	61.77	13.85	47.50	60.93	46.64
Testers	21.52	18.67	7.67	2.29	10.87	2.52	16.53	10.81	17.59	6.01	5.20
Line x Tester	32.33	36.52	80.27	78.95	58.68	48.86	21.70	75.34	34.91	33.06	48.16

Table 3. Estimates of general combining ability (g*ca*) effects of parents for yield and yield component traits in rice (*Oryza sativa* L.)

Parents	DFF	DM	PH (cm)	EBTs	PL (cm)	FG/P	UFG/P	SCMR	HI (%)	TW (g)	GY/P (g)
BPT 5204	6.13 **	6.13 **	-0.81	1.10 *	-0.94	16.37 **	-0.01	-0.65	3.29*	-0.53 **	8.28 **
MTU 1010	0.13	0.50	-1.48	-1.30 **	-1.02	-25.01 **	-3.79 **	-0.68	-4.32**	4.21 **	-4.14 **
JGL 11118	-4.75 **	-4.63 **	0.62	-1.02 *	0.83	5.92	1.43	1.49*	3.91**	-0.30	-4.92 **
RNR 2465	-1.13	-1.63 *	3.08 **	0.45	1.26 *	7.52	-2.66 *	0.12	-1.55	-0.98 **	1.91
WGL 48684	-0.38	-0.38	-1.42	0.77	-0.13	-4.80	5.03 **	-0.28	-1.34	-2.39 **	-1.13
NLR 34449	-3.50 **	-3.03 **	2.23 *	0.44	0.19	4.97	-1.91 *	0.17	-0.41	-1.19 **	-1.95 *
NLR 145	3.20 **	3.38 **	-1.44	-0.11	0.44	-0.61	1.40	-1.20*	-2.82*	0.37 *	-1.09
IR 36	-0.30	-0.32	-0.12	-0.48	0.30	-4.07	1.79	0.53	0.83	0.23	0.94
IR 64	0.60	-0.03	-0.66	0.16	-0.94	-0.29	-1.28	0.51	2.39*	0.60 **	2.09 *
CD 95% GCA(Line)	1.81	1.58	1.82	0.94	1.17	7.55	2.03	1.34	2.45	0.34	2.08
CD 95% GCA(Tester)	1.62	1.41	1.63	0.84	1.04	6.75	1.81	1.20	2.19	0.31	1.86

**Significant at 1% * Significant at 5%

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Table 4. Estimates of specific combining ability (*sca*) effects of crosses for yield and yield component traits in rice (*Oryza sativa* L.)

S.No	Crosses	DFF	DM	PH (cm)	EBTs	PL (cm)	FG/P	UFG/P	SCMR	HI (%)	TW (g)	GY /P(g)
1	BPT 5204 x NLR 34449	-5.63 **	-6.22 **	0.79	0.56	0.93	-4.47	-0.55	0.50	2.02	1.32 **	2.00
2	BPT 5204 x NLR 145	1.17	2.38	8.15 **	-1.59	-0.02	-26.89 **	2.09	-1.03	-1.02	0.31	-6.81 **
3	BPT 5204 x IR 36	6.68 **	7.07 **	-6.92 **	0.68	-0.68	17.57 *	-2.15	-0.22	2.43	-1.27 **	3.81
4	BPT 5204 x IR 64	-2.22	-3.22 *	-2.02	0.34	-0.24	13.79	0.62	0.75	-3.43	-0.36	1.01
5	MTU 1010 x NLR 34449	-3.13	-2.60	5.16 **	-1.54	0.31	34.40 **	3.83	1.77	1.48	-1.88 **	3.77
6	MTU 1010 x NLR 145	0.17	-0.50	-0.02	-0.79	-0.04	-17.51 *	-1.88	-1.36	1.79	3.53 **	-1.19
7	MTU 1010 x IR 36	-0.32	-0.30	-0.49	1.88 *	-0.90	-3.06	-0.06	-0.14	-2.06	-1.49 **	-0.32
8	MTU 1010 x IR 64	3.28	3.40 *	-4.65 *	0.44	0.64	-13.84	-1.89	-0.27	-1.22	-0.16	-2.27
9	JGL 11118 x NLR 34449	0.75	0.03	-4.24 *	1.38	-0.64	-11.22	-1.79	1.79	3.14	-0.13	3.35
10	JGL 11118 x NLR 145	0.05	0.63	-2.27	-0.57	0.61	19.56 *	-0.80	3.72**	1.76	-1.49 **	0.59
11	JGL 11118 x IR 36	-0.95	-1.17	8.31 **	-2.50 *	2.95 *	-4.48	1.81	-3.41*	-3.49	3.64 **	-3.14
12	JGL 11118 x IR 64	0.15	0.52	-1.80	1.70	-2.91 *	-3.86	0.78	-2.10	-1.41	-2.02 **	-0.79
13	RNR 2465 x NLR 34449	5.13 **	4.03 *	1.70	-2.79 **	-0.87	-5.92	-0.50	-4.18**	0.01	1.58 **	-3.03
14	RNR 2465 x NLR 145	0.93	1.13	-8.13 **	4.01 **	-1.42	10.96	-2.81	0.09	-2.43	-2.05 **	7.61 **
15	RNR 2465 x IR 36	-5.07 **	-4.68 **	0.65	-2.47 *	0.72	-6.28	1.90	2.41	-0.63	-0.09	-10.47 **
16	RNR 2465 x IR 64	-0.98	-0.47	5.79 **	1.25	1.56	1.24	1.42	1.68	3.06	0.56	5.88 **
17	WGL 48684 x NLR 34449	2.88	4.78 **	-3.40	2.39 *	0.27	-12.80	-0.99	0.12	-6.65*	-0.89 *	-6.09 **
18	WGL 48684 x NLR 145	-2.33	-3.63 *	2.27	-1.06	0.87	13.88	3.40	-1.41	-0.09	-0.30	-0.20
19	WGL 48684 x IR 36	-0.32	-0.93	-1.55	2.41 *	-2.09	-3.76	-1.49	1.36	3.75	-0.79 *	10.12 **
20	WGL 48684 x IR 64	-0.22	-0.22	2.69	-3.73	0.95	2.67	-0.92	-0.07	3.00	1.98 **	-3.83
	CD 95% SCA	3.61	3.15	3.65	1.88	2.34	15.10	4.05	2.69	4.91	0.69	4.17

**Significant at 1% * Significant at 5%