Journal of Agroecology and Natural Resource Management
p-ISSN: 2394-0786, e-ISSN: 2394-0794, Volume 3, Issue 2; July-September 2016 pp. 136-139

http://www.krishisanskriti.org/Publication.html

Identification of Superior Parents and Hybrids in Rice (Oryza Sativa L.)

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Abstract—*Line x tester analysis was carried out to estimate the heterosis and combining ability among forty hybrids obtained from mating between four females and ten males. Experimental results showed that per se performance of parents and hybrids agrees well with general combining ability effects of parents and heterotic response of hybrids. The crosses exhibiting higher per se performance, high heterosis and significant desirable sca effects for various traits involved either good x good, good x average, good x poor, average x good, average x average, average x poor, poor x good, poor x average and poor x poor combining parents. The best three hybrids for grain yield per plant namely NVSR-178 x NAUR-1 (good x good), NVSR-178 x IET-21682 (good x good) and IR-28 x NAUR-1 (poor x good) had significant desired sca effects and significant desired heterotic response over better parent.*

Keywords*: line x tester, combing ability effect, heterotic response and per se performance*

1. INTRODUCTION

Half of human population consume rice (Oryza sativa L.) as integral and unavoidable part of their daily diet. There is need to develop high yielding superior varieties and hybrids. Hence, identification of superior varieties and crosses from exiting breeding material is essential. Hence, present investigation using Line × Tester mating design was undertaken to assess the combining ability of fourteen parents and their forty crosses as well as to study the extent of heterosis for yield and yield contributing characters. The knowledge of nature and the magnitude of gene action controlling yield and yield components are very useful for selecting of the breeding procedures to be followed for crop improvement. It will provide systematic approach for identification of superior parents and crosses that is the basic material on which the success of breeding programme rests. Generally, identification of superior parents or cross is carried out on the basis of per se performance of that parent or cross. Hence, information regarding the per se performance is of vital importance to the plant breeder.

2. MATERIAL METHODS

The experimental materials for the present investigation comprising of four females viz., IET-19347, IR-28, NVSR-176 and NVSR-178 and ten males viz., IR81025-B-116-1, IR-79915-B83-4-4, IR79971-B-204-1-4, IR81024-B-254-4, IR80501-B-96-1-B, IET-21682, IET-21683, NAUR-1, RP-4075-129-07-3 and RP-4075-135-35-5 were procured from National Agricultural Research Project, Navsari Agricultural University, Navsari (Gujarat) to conduct experiment during rabi-2010-2011 to kharif-2011.

The crossing programme among the fourteen parents was carried out in line x tester mating design during rabi-2010-2011 to obtain forty cross combinations. Further in next season, three complete sets of 54 entries comprising of parents and hybrids were planted in Randomized Block Design (RBD) during kharif-2011. The trials were conducted, replicated thrice at three research stations of the university viz., Navsari (Loc-I), Vyara (Loc-II) and Waghai (loc-III). The parents and F1s were represented by a single row plot of 10 plants, placed at 20 x 15 cm. All the standard agronomical practices and plant protection measures were followed as per recommendations by university to raise good experimental crop. Five random competitive plants excluding border ones were selected from each row in each replication to record observations on ten characters viz., days to 50 per cent flowering, productive tillers per plant, plant height (cm), panicle length (cm), grain yield per panicle, 1000- grain weight i.e., test weight (gm), grain yield per plant (gm), kernel length: breadth ratio, amylose content (%) and protein content (%) were recorded in field and laboratory and mean values were subjected for statistical analysis.

The data for each character were analyzed independently for each location as well as pooled over locations by using standard statistical procedure [5]. Combining ability analysis was carried out according to method suggested by kampthorne [3].

3. RESULT AND DISCUSSION:

Analysis of variance for combining ability (Table No. 1) reveals that non-additive variances were important in the inheritance of various traits as evident from significance of females x males interaction for all the characters. Analysis of variance for combining ability (Table No. 1) reveals that non-additive variances were important in the inheritance of various traits as evident from significance of females x males interaction for all the characters. The combining ability variances found significant for the traits viz., productive tillers per plant, plant height (cm), 1000-grain weight (g), grain yield per plant (g), amylose content (%) and protein content (%) for female and productive tillers per plant, plant height (cm), panicle length (cm), L:B ratio and protein content (%) for males. The magnitudes of sca variances were higher than the gca variances for all the characters except plant height (cm) and L:B ratio which indicated preponderance of non-additive gene action in the inheritance of these traits, while preponderance of additive type of gene action in, plant height (cm), and L:B ratio. This was further it was reflected through low magnitude of σ2gca/σ2sca ratios for all the traits except plant height (cm) and L:B ratio. Preponderance of non-additive variance in the expression of different traits in rice has also been reported by Saidaiah and Singh [7,8]. Preponderance of additive gene action for plant height (cm) and L:B ratio was also reported by Vivekanandan and Giridharan and Singh [8,9].

Table No. 1: Analysis of variance (mean squares) of combining ability

Source of variance	d.f.	Days to 50 per cent flowering	Productive tillers per plant	Plant height (cm)	Panicle length (cm)	Grains per panicle	Test weight (g)	Grain yield per plant (g)	L:B ratio	Amylose content (%)	Protein content (%)
Replications	6@	10.231	0.392	1.643	0.755	47.901	0.047	8.700	0.003	0.116	0.002
Females (f)	3	165.148	38.832*	15777.824**	1.416	4622.941	362.876**	2297.563**	5.736**	68.272*	14.824**
Males (m)	9	377.281	29.677*	5336.344**	108.258**	4410.778	80.534	1078.530	0.847*	24.008	4.968*
Females x Males (fxm)	27	210.763**	9.161**	412.324**	31.573**	2339.057**	37.893**	487.050**	0.287**	16.336**	1.754**
Pooled error	702@	8.365	0.379	15.621	0.480	47.188***	0.253	5.611	0.010	0.054	0.013
Estimates											
$\sigma^2 f$		-0.556	0.324*	170.576**	0.071	25.859	3.613**	19.744*	0.061**	0.577*	0.145**
$\sigma^2 m$		4.702	0.583**	136.792**	2.994**	59.904	1.185	16.392	0.016*	0.212	0.090*
$\sigma^2 gca$		0.944	0.398**	167.325**	0.786**	35.586	2.919**	18.786*	0.048**	0.473*	0.130**
$\sigma^2 sca$		22.802**	0.895**	41.842**	1.659**	236.041**	4.162**	52.651**	0.030**	1.809**	0.191**
$\sigma^2 gca / \sigma^2 sca$		0.041	0.445	3.999	0.474	0.151	0.701	0.357	1.6	0.261	0.681

*, ** Significant at 5 and 1 per cent probability levels, respectively. @ = for individual location, d. f. = for error and replication were 2 and 234, respectively.

A perusal of (Table No. 2) showed a good agreement between best general combining parents and best performing parents for most of the traits. This suggested that while selecting the parents for hybridization programme, per se performance of parents should be given due weightage. It is also evident from result that the three best performing hybrids for various characters also had high heterotic response over better parent and desired sca effects. Therefore, it can be concluded that per se performance of parents and hybrids agrees well with general combining ability effects of parents and heterotic response of hybrids, respectively. Thus, the potentiality of a genotype to be used as a parent in hybridization, or a cross to be used as a commercial hybrid may be judged by comparing per se performance of parents and hybrids, along with combining ability effects of parents and heterotic response of hybrids. The crosses exhibiting higher per se performance, high heterosis and significant desirable sca effects for various traits involved either good x good, good x average, good x poor, average x good, average x average, average x poor, poor x good, poor x average and poor x poor combining parents. Thus, crosses exhibiting high sca effects did not always involve parents with high gca effects. It may be suggested that interallelic interactions were also important for these characters.

Table No.2: Summary of three best performing parents, best general combining parents and best performing hybrids along with their *gca* effects and *sca* effects and per cent heterosis for various traits.

Character	Best performing parents		Best general combiner		Best performing hybrids	*gca* effect	*sca* effect	Heterosis (%)
	Female	Male	Female	Male				
Days to 50 per cent flowering	IR-28	IR81025-B-116-1	IR-28	IET-21682	NVSR-176 X IET-21682	GXG	-2.18*	-8.08**
	NVSR-178	IR-79915-B83-4-4	NVSR-176	IR81025-B-116-1	IET-19347 X RP-4075-135-35-5	PXA	-9.05**	-19.40**
	NVSR-176	IR79971-B-204-1-4	NVSR-178	IR79971-B-204-1-4	NVSR-176 X IR81024-B-254-4	GXG	-5.33**	-6.23**
Productive Panicle per plant	NVSR-178	IET-21682	NVSR-178	NAUR-1	IR-28 X NAUR-1	AXG	1.48**	37.56**
	IR-28	NAUR-1	IR-28	IET-21682	NVSR-178 X NAUR-1	GXG	0.41*	27.66**
	NVSR-176	IET-21683	NVSR-176	RP-4075-129-07-3	NVSR-178 X IET-21682	GXG	1.04**	25.29**
Plant height (cm)	IR-28	RP-4075-129-07-3	IR-28	IET-21682	NVSR-178 X RP-4075-129-07-3	PXP	-12.80**	-14.15**
	NVSR-176	RP-4075-135-35-5	IET-19347	IR81024-B-254-4	IR-28 X RP-4075-129-07-3	GXP	14.25**	-11.14**
	NVSR-178	IET-21682	NVSR-176	IET-21683	IR-28 X RP-4075-135-35-5	GXA	9.51**	-10.68**
Panicle length	IR-28	NAUR-1	NVSR-178	NAUR-1	NVSR-178 X NAUR-1	GXG	0.31	7.46**
	NVSR-178	IR81024-B-254-4	IR-28	IET-21682	IR-28 X NAUR-1	AXG	0.62**	6.29**
	IET-19347	IET-21683	IET-19347	IR81024-B-254-4	NVSR-178 X IET-21682	GXG	1.41**	8.98**
Grains per panicle	IR-28	NAUR-1	NVSR-176	NAUR-1	NVSR-178 X NAUR-1	GXG	13.30**	32.09**
	IET-19347	IET-21682	IR-28	IET-21682	IR-28 X NAUR-1	GXG	10.51**	22.16**
	NVSR-178	RP-4075-135-35-5	NVSR-178	RP-4075-129-07-3	IR-28 X RP-4075-129-07-3	GXG	28.49**	20.40**

Table 2 contd...

Table No. 2 contd...

Character	Best performing parents		Best general combiner		Best performing hybrids	*gca* effect	*sca* effect	Heterobeltiosis (%)
	Female	Male	Female	Male				
Test weight	NVSR-176	IR81025-B-116-1	IET-19347	NAUR-1	NVSR-178 X IET-21682	GXG	2.58**	6.03*
	NVSR-178	IR79971-B-204-1-4	NVSR-176	RP-4075-129-07-3	NVSR-178 X NAUR-1	GXG	0.23	4.49*
	IR-28	IR-79915-B83-4-4	NVSR-178	IR81025-B-116-1	NVSR-176 X IR81025-B-116-1	GXG	1.31**	0.89
Grain yield per plant (g)	NVSR-178	NAUR-1	NVSR-178	NAUR-1	NVSR-178 X NAUR-1	GXG	9.17**	49.89**
	IR-28	IET-21682	NVSR-176	IET-21682	NVSR-178 X IET-21682	GXG	14.49**	44.17**
	NVSR-176	IET-21683	IR-28	IR81025-B-116-1	IR-28 X NAUR-1	PXG	3.52**	39.51**
L:B Ratio	IR-28	IET-21683	IR-28	IR80501-B-96-1-B	IR-28 X RP-4075-129-07-3	GXA	0.16**	0.43
	NVSR-176	IR80501-B-96-1-B	IET-19347	IR81024-B-254-4	IR-28 X NAUR-1	GXG	0.6	-0.29

	IET-19347	RP-4075-129-07-3	NVSR-176	RP-4075-135-35-5	IR-28 X IR80501-B-96-1-B	GXG	-0.11**	-0.64
Amylose	IET-19347	IR79971-B-204-1-4	IET-19347	NAUR-1	NVSR-178 X NAUR-1	PXG	0.99**	11.78**
	IR-28	IR-79915-B83-4-4	IR-28	IR-79915-B83-4-4	IR-28 X NAUR-1	AXG	0.57**	8.52**
	NVSR-178	IR81024-B-254-4	NVSR-178	RP-4075-129-07-3	IET-19347 X NAUR-1	GXG	-0.94**	1.15**
Protein	IR-28	IET-21682	IR-28	IET-21682	IR-28 X IR81025-B-116-1	GXP	1.11**	8.93**
	NVSR-176	IR81024-B-254-4	NVSR-176	IR81024-B-254-4	IET-19347 X IR81024-B-254-4	PXP	1.00**	11.38**
	NVSR-178	IR80501-B-96-1-B	NVSR-178	RP-4075-135-35-5	IR-28 X IET-21682	GXP	-0.08*	-0.82

*, ** Significant at 5 and 1 per cent probability levels, respectively; G = Good parent having significant *gca* effect in desired direction; A = Average parent having either positive or negative but non-significant *gca* effects; P = Poor parent having significant *gca* effects in undesired direction

The best three hybrids for grain yield per plant namely NVSR-178 x NAUR-1 (good x good), NVSR-178 x IET-21682 (good x good) and IR-28 x NAUR-1 (poor x good) had significant desired sca effects and significant desired heterotic response over better parent. High yielding hybrids had high sca effects, high heterosis as well as high per se performance for most of the yield contributing characters. This appeared appropriate as yield being a complex character depends on a number of its component traits.

The results revealed that parents with good per se performance were ordinarily, good combiners for most of the traits. Further, good general combiners may not necessarily produce good specific combinations for different traits. Similar results were reported by Ramlingam [7]. In many cases, it was observed that at least one good general combining parent was involved in heterotic hybrid having desirable sca effects. This was true for most of the traits studied. Parents with highest gca effects will not necessarily generate top specific cross combinations was also reported by Bhanumathy and Prasad, Ramalingam et al., Haripasanna et al. and Singh [1,6,2 & 8].

The hybrid NVSR-178 x NAUR-1 resulted from one poor and one good general combiner. This might be due to additive x dominant type of interaction with non-additive, non-fixable genetic component for grain yield. Random mating and selection among the segregants could lead to transgressive desirable early segregants in later generations as suggested by Langham [4]. It reveals that for predicting the value of any hybrid, information of gca effects of parents should be considered along with sca effects and per se performance of hybrid. It is therefore essential to search out parental lines with high gca effects and low sensitivity to environmental variation in a crop improvement programme.

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