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Heritability study in hybrid rice (*Oryza sativa* L.)

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Abstract
Study of heritability were conducted on F_1 hybrids along with rice genotypes (3 cms lines and 4 restorers) and three checks to know the pattern of inheritance of some morphological traits for selecting superior genotypes. The experiment was carried out according to line x tester mating design, during 2015-16. Analysis of variance revealed significant differences among genotypes, crosses, lines, testers and line x tester interactions for most of the traits. Ratio of SCA variances were higher than the GCA variances for traits which indicated predominance of non-additive gene action in the inheritance of the traits. The highest broad sense heritability (ns) was observed for grain yield (74.46%) and straw yield (74.13%).

Keywords: Heritability, hybrids, line x tester and rice

Introduction
Rice is staple food of more than 60% of Indian population. It accounts for about 43% of total food grain production and 46% of total cereal production in the country. Rice occupies pivotal place in Indian Agriculture. In order to meet the domestic demand of the increasing population the present day production of 107.40 million tons (Annonymous, 2015-16) [1] of milled rice has to be increased to 125 million tons by the year 2030. Since the yield of high yielding varieties (HYVs) of rice is plateauing, it is rather difficult to achieve this target with the present day inbred varieties. Therefore, to sustain the self-sufficiency in rice, additional production of 1.17 million tons is needed every year. Among many genetic approaches being explored to break the yield barrier in rice and increased productivity, hybrid rice technology appears to be the most feasible and readily adaptable one. Extensive research work is going throughout India and abroad on different aspects of hybrid rice. Several pioneer hybrids have shown a yield advantage of around 20% over current three line hybrids on commercial scale. The average yield of rice hybrids is 6.3 t/ha while that of the inbred varieties is 4.5 t/ha (Long ping, 2004) [10]. Therefore, the breeders are now making concentrated efforts to evolve better hybrids for varying ecological situation and to develop appropriate agronomy along with augmenting seed supply by producing quality seeds of recommended hybrids. Therefore, the present piece of research work reports the results of magnitude of heritability and heterosis for yield and its attributes. Therefore, hybridization programme made at Regional Agriculture Research Station, Karjat. Dist. Raigad. (MS) to estimate the nature and magnitude of heterosis and combining ability studies for different yield and yield contributing traits in rice.

2. Materials and Methods
2.1. Plant Materials
The experiment was conducted at the Experimental farm of Regional Agriculture Research Station, Karjat (Raigad). The identified parents were growing during December, 2015 and the crossing programme was under taken during April, 2016 and evaluation of F_{1s} along with parents and three standard checks was done during *kharif* 2016. Three CMS lines *viz*., IR58025A, RTN 12A and RTN17A were crossed with four testers Chedo Local, CR-2829-PLN-36, NPQ-49 and RP-5898-19-8-6-1-1-1 in a Line × Tester mating design developed 12 hybrids. The experiment was laid out in a Randomized Block Design with three replications during *kharif*, 2016 at Regional Agriculture Research Station, Karjat (Raigad). The experimental material consisting of twelve F_{1s}, three CMS lines, four restorers and three standard checks were sown on 21 June 2016. Then twenty-five days old seedlings were transplanted in the main field at 20 x 15 cm spacing with single seedling per hill having plot size 3 x 0.60 m. The recommended fertilizers @ 100 kg N, 50 kg P_2O_5 and 50 kg K_2O alongwith 7.5 tonnes of FYM per hectare were applied. All standard agronomic recommended practices and plant protection measures were adopted for raising healthy crop.

2.2. Statistcal Analysis

Five sample plants were randomly selected from each plot excluding the border plants and the following data were recorded: Plant height, days to 50% flowering, number of productive tillers plant^{-1}, panicle length, total spikelet panicle^{-1}, filled spikelet panicle^{-1}, spikelet fertility, grain yield plant, straw yield plant, harvest index, 1000 grain weight and days to maturity. The estimation of broad-sense heritability (hb) and narrow-sense heritability (ns) were also estimated according to Falconar & Mackey (1996) [2]. Combining ability analysis using line × tester mating design by Kempthorne (1957) [7].

Results and Discussion

3.1. Combining ability analysis

The analysis of variance revealed significant genotypic effect for all the characters under study for parents except for productive tillers plant^{-1} and panicle length. This provides evidence for the presence of sufficient genetic variability among lines, testers and test crosses indicating wide diversity among treatment themselves (Table no.1.). Significance mean sum squares of females and males indicated prevalence of additive variance whereas, non-additive variance by line x tester. Variance due to interaction effect of male and female were found to be highly significant for all the traits under study except number of productive tillers plant^{-1}, panicle length and grain yield plant^{-1}. The mean square due to hybrids were found to be highly significant for all the traits under study except number of productive tillers plant^{-1}. This indicated existence of considerable amount of genetic variability among parents and hybrids for all the traits under study. The parents vs. hybrids comparison was found significant for all the characters indicating substantial amount of heterosis in hybrids. Similar results reported by Sanghera *et al.* (2012) [12], Latha *et al.* (2013) [9], Islam *et al.* (2015) [6] and Khute *et al.* (2015) [8].

3.2. Heritability

The heritability of character has a major impact on the methods chosen for population improvement, in breeding and other aspect of selecting single plant selection may be effective for character with low heritability (5 to 10%), medium (10 to 30%), high (30 to 60%) and above (60%) very high heritability (Robinson, 1966).

Very high heritability estimates were obtained for the characters *viz.*, grain yield plant^{-1} (74.46%), straw yield plant^{-1} (74.13%), and panicle length (66.50%). High heritability estimates were obtained for the characters *viz.*, 1000 grain weight (57.69%), number of filled spikelets panicle^{-1} (52.18%), plant height (50.83%), days to 50 per cent flowering (47.96%) and days to maturity (47.79%) and medium heritability estimates were obtained for the characters *viz*., spikelet fertility (24.80%), total number of spikelets panicle^{-1} (19.16%), harvest index (15.46%) and number of productive tillers plant^{-1} (12.50%). Similar results reported by Saleem *et al.* (2008) [11], Tiwari (2011) [14], Hussain *et al.* (2014) [5] and Ghara *et al.* (2014) [4].

In examining the analysis of variance of line X tester is significance for most of the characters. The results showed that high heritability for grain yield plant^{-1} and its related traits which can be exploited in practical breeding.

Table 1: Analysis of variance in Line x Tester analysis for twelve characters in Rice.

Source of variation	DF	Characters											
		Days to 50 per cent flowering	Plant height (cm)	No. of productive tillers plant^{-1}	Panicle length (cm)	Total no. of spikelets panicle^{-1}	No. of filled spikelets panicle^{-1}	Spikelet fertility (%)	1000 Grain weight (g)	Grain yield plant^{-1} (g)	Straw yield plant^{-1} (g)	Harvest index (%)	Days to maturity
Replication	2	0.018	7.78	1.31	0.36	92.57	49.42	5.14	0.025	0.14	0.36	0.40	0.018
Parents	6	5.38**	370.27**	0.79	0.39	445.97**	370.02**	31.23**	9.15**	6.22**	88.1**	6.60**	5.38**
Male	3	9.33**	326.52**	0.83	0.67	722.92**	298.51**	39.64**	2.27	3.44	122.2**	57.56**	9.33**
Female	2	1.00	36.00**	0.05	0.12	22.46**	9.00	5.75**	4.78**	13.09**	6.88	3.21**	1.01
Male vs Female	1	2.28**	1170**	2.15	0.09	462.13**	1306.61**	56.96**	38.5**	0.82	148.1**	77.19**	2.27
Hybrids	11	54.45**	107.38**	1.15	8.55**	85.67**	234.96**	19.08**	4.74**	63.25**	55.15**	4.48**	54.46**
Parents vs. Hybrids	1	102.92**	7.86**	154.54**	112.6**	2725.1**	9036.16**	359.4**	87.15**	838.3**	221.1**	206.56**	102.91**
Line effect	2	22.75**	11.86**	0.475	0.510	196.82**	566.75**	19.33**	3.95**	10.42**	4.49**	8.08**	22.7**
Tester effect	3	155.00**	376.48**	2.77**	30.08**	104.21**	380.48**	35.24**	8.55**	224.29**	194.36**	9.21**	155.00**
Line vs. Tester effect	6	14.75**	4.67**	0.578	0.479	39.34**	51.59**	10.92**	3.10**	0.353	1.77	0.915	14.7**
Error	36	3.24	18.58	0.71	1.07	87.03	50.65	2.64	0.54	5.17	4.14	6.47	3.25

*p< 0.05, **p< 0.01

Table 2: Estimation of heritability for twelve characters.

Sr. No.	Genetic parameters Characters	σ^2GCA	σ^2SCA	σ^2GCA / σ^2GCA	σ^2E	H^2 (%)
1	Days to 50 per cent flowering	7.06	3.54	1.99	4.12	47.96
2	Plant height (cm)	18.05	-6.40	-2.82	23.86	50.83
3	Number of productive tillers plant^{-1}	0.100	-0.07	-1.43	0.77	12.50
4	Panicle length (cm)	1.41	-0.12	-11.75	0.83	66.50
5	Total number of spikelets panicle^{-1}	10.59	-2.67	-3.97	47.34	19.16
6	Number of filled spikelets panicle^{-1}	40.19	7.38	5.45	29.45	52.18
7	Spikelet fertility (%)	1.56	3.10	0.50	1.63	24.80
8	1000 grain weight (g)	0.30	0.83	0.36	0.61	57.69
9	Grain yield plant^{-1} (g)	11.14	-1.73	-6.44	5.55	74.46
10	Straw yield plant^{-1} (g)	9.40	-0.75	-12.53	4.03	74.13
11	Harvest index (%)	0.73	-1.54	-0.47	5.53	15.46
12	Days to maturity	7.05	3.58	1.96	4.12	47.79

σ^2E – Environmental variance and H^2 - Heritability

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