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Combining ability analysis for hispa resistance in rice

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ABSTRACT

Combining ability hispa resistance along with other yield attributing traits in rice was studied through Line x Tester analysis involving two lines and seven testers. The mean squares of combining ability for line x tester interaction were significant for all the characters. The Combining ability analysis revealed non-additive gene action for all the characters except for plant height. Among the lines IR-50, and among the testers AS-36 and Begonbisi were found to be the best general combiner. Two crosses viz; Mahsuri x Begonbisi and IR-50 x Govind showed desirable sca effects for grain yield and hispa resistance. Implications of these results were discussed for breeding high yielding varieties with hispa resistance.

Key words: *line x tester analysis, combining ability, GCA, SCA, rice hispa*

The future food security of India rests on the ability to improve the productivity and profitability of rice farming system. The major limitation for enhancing productivity of rice is the dearth of adequate knowledge on the genetics of resistance to pest and diseases. Among the pests of rice in Assam, rice hispa (*Dicladispa armigera*; Coleoptera; Chrysomelidae) is one, which causes extensive damage to the crop at the vegetative stage. A yield loss up to 100% was also recorded under post flood situation of Assam (Dutta and Hazarika,1992) Varietal resistance is considered essential for suppressing the outbreak of rice hispa, which has been given the topmost priority in the integrated pest management system (IPM). The study of combining ability analysis helps in evaluation of lines in terms of their values in the selection of parents for hybridization along with identification of superior cross combination to obtain transgressive segregants. Additionally, knowledge on the genetic architecture of the population would be very much desirable in a breeding programme for rice hispa resistant variety. Available literature suggests that information on these aspects for rice hispa resistance are lacking. Therefore, the present investigation was carried out to find out the gene action and good combining parents that could be used for breeding hispa resistant variety.

MATERIALS AND METHODS

Two most popular high yielding varieties of Assam, otherwise susceptible to rice hispa (Mahsuri and IR-50) were crossed with seven tolerant lines genotypes were identified by Dutta and Hazarika (1992) (Mala, Govind, Bizor-3, Begonbisi, Garem, AS-75 and AS-36) in a line x tester fashion (Kempthorne, 1957) The parents and the crosses were raised during *Sali* (transplanted in August) season at Assam Agricultural University, Jorhat in a randomized block design with five replications. One-month old seedlings of each genotype were transplanted in three row-plot of three-meter length with a spacing of 25 cm between rows and 20 cm between plants. The experiment was conducted under mosquito net to facilitate the release of rice hispa for feeding. All the agronomic practices were followed as per recommendations. No insecticides were applied. For screening hispa damage, at least ten starved adult hispa plant^{-1} was released under the mosquito net and then number of infested leaves and total number of leaves was recorded after 7 days and the percentage of damage was calculated (Dhaliwal,1980). The other observations recorded were number of tillers, days to flowering, plant height, days to maturity, number of panicle, panicle length, grains panicle^{-1}, 100-grain weight and grain yield plant^{-1}.

RESULT AND DISCUSSION

The analysis of variance revealed highly significant differences among the entries for rice hispa resistance and other traits (Table 1). The parents also differed significantly indicating great deal of diversity among them. Significant variations were observed for parents versus crosses for all the characters excepting number of tillers and number of panicle. This shows the expression of heterosis for these characters. Significant mean squares due to testers, lines and crosses for rice hispa resistance and other agronomic traits revealed wide range of diversity for these characters. The differences due to lines, testers and lines X testers interactions were significant, suggesting the importance of both additive and non-additive gene action in the inheritance of rice hispa resistance and other yield attributes.

In the study, the sca effect was higher than the gca effects for all the characters, except for plant height (Table 2). It indicated the operation of non-additive gene action for these traits excepting plant height, which revealed the scope for exploiting heterosis along with the possibility to obtain better recombinant through transgressive segregation (Comstock *et al.*, 1949). However the ultimate adoption of breeding method depends upon the combining abilities of the parents and the crosses and the nature of gene actions for these characters.

In breeding for rice hispa resistance, the parents with negative gca effects, indicating low hispa damage is desirable. Among the lines, IR-50 showed negative GCA (Table 3) with high incidence of rice hispa damage suggesting the potentiality of producing desirable segregant in later generation for rice hispa resistance when this parent is used in hybridization programme. This indicates that only mean performance does not reflect the potentiality of a parent in breeding for rice hispa resistance. Similar report was reported by Ganapathy and Marimuthu (Ganapathy and Marimuthu, 1999) in combining ability analysis for rice tungro virus. IR-50 also showed desirable gca effects for number of effective tillers, plant height, number of panicle, number of grains panicle^{-1} and 100-grain weight. So IR-50 could be considered for inclusion as parent in

Table 1. ANOVA for Line x Tester for rice hispa resistance and other agronomic traits

Source	Degrees of freedom	Hispa damage (%)	No. of tillers plant^{-1}	Days to flowering	Plant height (cm)	Days to maturity	Panicle length (cm)	No. of panicle plant^{-1}	Grains panicle^{-1}	100 grain weight (g)	Yield plant^{-1} (g)
Lines	1	1799.546**	134.414**	64.128**	8487.609**	308.700**	35.528**	134.4143**	25859.357*	0.015**	3021.674**
Testers	6	3776.085**	28.157	378.757**	2241.170**	845.014**	8.012**	28.15714	4902.243*	0.116**	1036.250**
Crosses	13	2144.998**	42.880**	201.034**	1732.935**	485.122**	13.295**	42880.22**	6971.941**	0.077*	1782.667**
L x T	22	571.486**	42.347**	46.129**	98.921	154.633**	14.873**	42.34762**	5893.7372**	0.049*	2322.583**
Pr Vs. Cr	1	613.000*	15.510	151.370**	3537.090**	1080.600**	8.740**	15.510	12812.69	3.220**	458.350**
Parents	8	1856.330**	29.400**	449.220**	2508.930**	45.000**	13.300**	29.400	3285.45**	6.910**	6118.950**
Error	88	8.040	9.630	6.219	45.808	0.512	2.27	9.480	591.1435	0.000455	121.482

*P≥ 0.05; **P≥ 0.01

Table 2. Combining Ability Variance for rice hispa resistance and other agronomic traits

Paremeter	Hispa damage (%)	No. of tillers	Days to flowering	Plant height (cm)	Days to maturity	Panicle length (cm)	No. of panicle plant^{-1}	Grains panicle^{-1}	100 grain weight (g)	Grain yield plant^{-1}
σ^2 gca	30.760	0.010	3.028	31.943	6.461	21.078	0.023	-0.031	0.0006	-10.555
σ^2 sca	112.690	6.540	7.982	10.623	30.824	1060.520	7.982	2.522	0.0096	440.220
σ^2 gca:s^2 sca	0.273	0.002	0.379	3.007	0.209	0.0199	0.003	-0.0123	0.062	0.024
σ^2 A	61.520	0.621	6.056	63.886	12.922	42.156	0.046	-0.062	0.0012	-21.110
σ^2 D	112.690	6.540	7.982	10.623	30.824	1060.520	7.982	2.522	0.0096	440.220

Table 3. GCA effects of parents for rice hispa resistance and other agronomic traits

	Hispa damage (%)	No. of tillers plant^{-1}	Days to flowering	Plant height (cm)	Days to maturity	Panicle length (cm)	No. of panicle plant^{-1}	Grains panicle^{-1}	100 grain weight (g)	Grain yield plant^{-1} (g)
Mahsuri	5.070**	-1.386*	0.957	11.011**	-2.100**	0.712*	-1.386**	19.220**	-0.014**	6.570**
IR-50	-5.070**	1.386*	-0.957	-11.011**	2.100**	-0.712*	1.386**	-19.220**	0.014**	-6.570**
Mala	4.994**	-1.371	6.829**	-8.011**	4.414**	-0.522	-1.371	27.380**	-0.062**	11.066
Govind	14.881**	3.029*	4.829**	-10.691**	6.614**	0.807	3.029*	9.968	0.076**	0.948
Bizor-3	12.706**	-1.271	4.129**	-23.971**	12.014**	0.645	-1.271	30.068**	0.049**	-11.675*
Begonbisi	-29.584**	-0.871	1.429	19.939**	2.614**	1.067	-0.871	-10.781	-0.197**	-13.729**
AS-75	1.621	0.229	-4.071**	4.339	-3.886**	-0.398	0.229	-20.242*	0.105**	-0.621
AS-36	-24.324**	1.429*	-10.771**	10.929**	-15.386**	-1.467*	1.429**	-18.052*	0.075**	0.877

*P≥0.05; **P≥0.01

the hybridization programme.

Among the testers, desirable gca effect for hispa damage was observed for Begonbisi and AS-36. These two parents also showed moderate resistance to hispa damage. Thus it could be suggested that the *per se* performance alone cannot be the sole criterion for selection of parents for hybridization programme. Because the parents having desirable mean may not be a good combiner. Hence in those parents showing close correspondence between *per se* performance and their gca, then the gca effects parents needs to be considered as confirmatory in hybridization programme. So two testers, Begonbisi and AS-36, may be taken up to generate desirable segregant for selection.

For yield, amongst the lines, significant gca effect was exhibited by Mahsuri (Table 3). Mahsuri further exhibited desirable gca effects for early maturity, longer panicle length and higher number of grains panicle^{-1}.

Among the testers, Garem had maximum gca effects followed by Mala for yield. Garem further exhibited desirable gca effects for early flowering and maturity. On the other hand, Mala showed significant gca effects for higher number of grains panicle^{-1} and reduced plant height.

Six crosses were identified as good specific combiner for hispa resistance (Table 4). These were IR-50 x Mala, IR-50 x Govind, Mahsuri x Bizor-3, Mahsuri x Begonbisi, Mahsuri x Garem and Mahsuri x AS-75. For grain yield, Mahsuri x Begonbisi, Mahsuri x Mala and IR-50 x Garem. They showed desirable sca effect. The sca effects represent the dominance and epistasis effect and can be an index to determine the usefulness of a particular cross combination in the exploitation of heterosis.

In the present study, among the crosses, only Mahsuri x Begonbisi and IR-50 x Govind showed desirable sca effect for both hispa damage and grain yield. Mahsuri x Begonbisi also showed significant sca effect for 100-grain weight and IR-50 x Govind showed desirable sca effects for early maturity and 100-grain weight. It was observed that the crosses Mahsuri x Begonbisi and IR-50 x Govind involved high x low gca combinations for both hispa damage and grain yield.

Table 4. SCA effects of the crosses for rice hispa resistance and other agronomic traits

	Hispa damage (%)	No. of tillers plant^{-1}	Days to flowering	Plant height (cm)	Days to maturity	Panicle length (cm)	No. of panicle plant^{-1}	Grains panicle^{-1}	100 grain weight (g)	Yield plant^{-1} (g)
Mahsuri x Mala	14.341**	1.485	-2.257	-5.471	2.300**	-0.892	1.485	-40.528**	-0.107**	18.101**
Mahsuri x Govind	6.144**	-2.514	-2.257	3.688	2.100**	1.350	-2.514	33.241**	-0.063**	-9.427
Mahsuri x Bizor-3	-5.960**	-0.614	-1.357	2.668	2.700**	0.090	-0.614	19.901	0.105**	-13.448*
Mahsuri x Begonbisi	-5.070**	1.785	0.142	2.098	2.100**	-0.795	1.785	-13.923	0.023*	22.123**
Mahsuri x Garem	-5.070**	0.685	0.742	-0.511	-6.900**	-0.905	0.685	-8.449	-0.014	-15.525**
Mahsuri x AS-75	-3.395*	2.085	3.642**	-0.541	-4.400**	2.021**	2.085	11.193	0.023*	-6.570
Mahsuri x AS-36	-0.990	-2.914	1.342	-1.931	2.100**	-0.869	-2.914	-1.436	0.033**	4.745
IR 50 x Mala	-14.341**	-1.485	2.257	5.471	-2.300**	0.892	-1.485	40.528**	0.107**	-18.101**
IR 50 x Govind	-6.144**	2.514	2.257	-3.688	-2.100**	-1.350	2.514	-33.241**	0.063**	9.427
IR-50 x Bizor-3	5.960**	0.614	1.357	-2.668	-2.700**	-0.090	0.614286	-19.9017	-0.105**	13.44814*
IR 50 x Begonbisi	5.070**	-1.785	-0.142	-2.098	-2.100**	0.795	-1.78571	13.92329	-0.023*	-22.1239**
IR-50 x Garem	5.070**	-0.685	-0.742	0.5119	6.900**	0.905	-0.68571	8.449286	0.015	15.52514**
IR-50 x AS-75	3.395*	-2.085	-3.642**	0.541	4.400**	-2.021**	-2.08571	-11.1937	-0.023*	6.570143

The high sca effects of such crosses might be attributed to additive x dominance type of gene action. In other words, the high yield potential of the crosses were attributed to the interaction between positive alleles from good combiner and negative alleles from poor combiners (Dubey, 1975). The high yield potential along with hispa resistance of these crosses could not be fixed in the subsequent generations and might not be exploited by standard selection procedures. However these crosses might produce transgressive segregant in the later generations, if efforts are made to capitalize on the additive and the non–additive gene actions. In such situation, the use of recurrent selection, which involves cyclic intermating of the selects, appears to be most desirable selection procedure. However in self-pollinated crops like rice, recurrent selection in true sense is difficult to practice. Under such circumstances, biparental mating in the early generations might be practice to ensure optimum utilization of both additive and non-additive gene action.

Thus this study has been helpful to identify the specific crosses with high sca effects and parents involving high/low sca effects for hispa resistance and yield attributing characters and can be exploited directly for heterosis breeding.

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