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Gene action in hybrid rice (*Oryza sativa* L.)

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Abstract
The present investigation was carried out to study the general combining ability effects of parents, specific combining ability effects of their hybrids. Female, IR-58025 recorded significantly high gca effects (4.88**) as well as maximum (29.12 gm) grain yield/plant indicating its good general combining ability for higher yield. Similarly among males IR-46 recorded maximum gca effects (7.98**) followed by IET-16310 (7.33**) and IR-34686-179-1-2-1 (5.13) indicating their good general combining ability for this trait. The crosses with high sca effects were in general combinations of parents with good x good or good x average gca effects. In many cases it was observed that atleast one good general combining parent was involved in heterotic hybrids having desirable sca effects. This suggested that information of the gca effects of parents should be considered along with sca effects and per se performance of hybrids for predicting the value of any hybrid.

Keywords: General combining ability, specific combining ability, non-additive

Introduction

Humanity faces the biggest problem in 21st century is to be made available adequate food and nutrition for huge global population with the ever shrinking resources base. Demand for rice is expected to grow faster than production in most countries so much that by the year 2025, 800 million tones of it will be needed annually (Anonymous, 1994) [1]. Population increase will be more in developing countries where rice is the staple food. It is crucial step for a breeder to select right type of parents in hybridization programme. Combining ability analysis is a powerful tool to discriminate good as well as poor combiner and selecting out appropriate parental material and type of gene action involved in the inheritance of various traits. A knowledge of type of gca effects and their magnitude is of fundamental importance to the plant breeder. The present investigation in rice (*Oryza sativa* L.) was therefore undertaken with an objective to estimate the general and specific combining ability of the parental lines and their hybrids using L x T analysis.

Experimental material

The experimental material for the present investigation consisted of 29 parents (4 females, and 25 males) and their 100 crosses, where, Gurjari and Sahyadri used as check. The seeds of these parents were obtained from Main Rice Research Station, Nawagam. The crossing programme was carried out using 4 CMS lines and 25 pollen parents (Restorers) adopting isolation free system (advocated by Virmani and Casal, 1993) during *kharif* 2001 and Summer 2002 at the NARP Farm, GAU, Navsari. Thus seeds of 100 experimental crosses were obtained. Three complete sets of 131 entries comprising of 100 F_1s, 4 females and 25 males and 2 checks were evaluated during *kharif* 2002 at three locations *viz*., Navsari, Vyara and Wghai. The trials were conducted in a Randomized Block design (RBD), replicated thrice in the three different locations.

Results

It was observed from the study of estimates of various components that gca variances due to males and females were found to be significant at individual location and in pooled analysis. Similarly sca (females x males) component was found to be highly significant at all the three location and in pooled analysis. Thus, though both gca and sca variances were significant, higher magnitude of latter variance at all the three location and in pooled analysis indicated importance of dominance and dominance x dominance and additive x dominance types of epistatic variances in the inheritance of grain yield/plant. Among the interactions variances due to males x locations and females x males x locations interactions were found to be significant. This revealed influence of environment on both the variances. A comparison of σ^2sca x location and σ^2sca x location/ σ^2gca x location ratios indicated that the sca variance exhibited greater influence of environmental changes.

The estimates of general combining ability effects indicated that out of twenty nine parents, two females and ten males exhibited significant gca effects for this character. Maximum grain yield among males was recorded by IR-20933 (30.53 gm) followed by IR-40750-82-2 (30.1 gm) and IR-40750 (29.64).

Total sixty eight crosses depicted significant sca effects from with a range from -12.94 (IR-68887 x IET-16310) to 12.68** (IR-68886 x IET-16310), of these thirty three crosses had sca effects in positive direction. The best female general combiner IR-58025 was involved in 11 crosses while poorest female general combiner IR-68887 was involved in eight cross combinations which had significantly positive sca effects. Out of thirty three crosses which depicted significant positive sca effects, the frequency of good x good general combiner was very less (only 4 crosses) whereas the frequency of poor x poor (11 crosses) and poor x good combiner (8 crosses) was high in contrast to this, majority of the high yielding hybrids involved both the parents with good general combining ability for Grain yield/plant

Discussion

The estimates of components of variance and their ratio (σ^2 sca/σ^2 gca) on pooled basis indicated preponderance of non-additive type of gene action in the expression of panicle length, productive tillers per hill, spikelet fertility, grain yield/hill, straw yield/hill, L: B ratio and milling recovery percentage.

As observed in the present study, the predominant role of non-additive gene action in the inheritance was observed by many workers for grain yield per plant (Singh *et. al.* 1998; Shanmugvalli *et. al.*, 1999; Kalita and Upadhya, 2000; Lavanya, 2000; Satyanarayan *et. al.* 2000 and Annadurai and Nandrajan, 2001) [2] From the above discussion it is clear that hybrids IR-68886 x IET-16310 and IR-58025 x IET-16310 having high mean, high economic heterosis and desirable sca effects for grain yield per plant and its related traits can be exploited in practical plant breeding.

Table 1: Analysis of variance for combining ability for Grain yield/plant

Sources of variation	DF	Grain yield /plant gm			
		NVS	VYA	WGH	Pooled
Locations	2				335.92**
Females	3	1102.12	994.86	1058.32	3006.57
Males	24	230.90	288.38	234.84	469.91
F X M	72	115.32	95.50	134.90	166.26
Females X Loc	6				74.35
Males X Loc	48				142.10
F x M x Loc	144				89.73
Pooled error	594				6.58
σ^2 f		13.16**	11.99**	12.31**	12.69**
σ^2 m		9.63*	16.07**	8.33*	6.98**
σ^2 fm		36.45**	29.30**	42.92**	25.51**
σ^2 f x l					-0.21
σ^2 m x l					4.36*
σ^2 fm x l					27.72**
σ^2 gca		12.67	12.56	11.76	11.90
σ^2 sca		36.45	29.29	42.92	25.51
σ^2 sca/σ^2 gca		2.88	2.33	3.65	2.14
σ^2gca x Loc					0.43
σ^2sca x Loc					27.72
σ^2sca x Loc / σ^2gca x Loc					65.22

*,** significant at 5% and 1%

Table 2: Estimates of Specific combining ability (sca) effects of hybrids for Grain yield/plant (pooled)

		Parents	Gca effests		Hybrids	Specific combining ability (sca) effects			
Females	1	IR 58025 B	4.88**		Male ↓				
	2	IR 68886 B	0.26*		Female →	IR-58025	IR-68886	IR-68887	IR-68888
	3	IR 68887 B	-3.80**	1	IR 46	0.64	-0.34	-3.67**	3.37**
	4	IR 68888 B	-1.34**	2	IR 5442	2.53**	2.25**	-0.51	-4.27**
Males	1	IR 46	7.98**	3	IR 21567	-0.16	0.60	3.39**	-3.83**
	2	IR 5442	3.74**	4	IR 9761	3.13**	-1.82**	0.67	-1.98**
	3	IR 21567	0.02	5	IR 20933	-2.76**	0.71	0.00	2.05**
	4	IR 9761	-1.43**	6	IR 58232	-1.60*	-4.17**	1.02	4.75**
	5	IR 20933	0.63**	7	IR 40750	2.19**	1.99**	-2.47**	-1.70**
	6	IR 58232	1.25**	8	IR 31802	-4.11**	-3.89**	7.86**	0.14
	7	IR 40750	1.52**	9	IR 35366	0.16	0.58	0.35	-1.09
	8	IR 31802	-3.90**	10	IR 32809	2.31**	1.35*	-0.57	-3.10**
	9	IR 35366	-3.35**	11	IR 40750-82-2	-0.18	0.72	0.25	-0.79
	10	IR 32809	-3.81**	12	IR 58113-62-3	-9.20**	1.05	2.44**	5.71**
	11	IR 40750-82-2	-2.19**	13	IR 49615-113-1-3	-4.79**	3.76**	2.50**	-1.47*
	12	IR 58113-62-3	-2.23**	14	IR 29341-41-1	2.71**	-0.24	1.53*	-4.00**

	13	IR 49615-113-1-3	1.71**	15	IR 56455-206-2	-2.92**	1.73**	3.82**	-2.63**
	14	IR 29341-41-1	4.34**	16	IR 50404-57-2-2	-2.50**	-3.66**	3.65**	2.50**
	15	IR 56455-206-2	-1.24**	17	IR 45461-129-3-3-3	-8.08**	-1.19	-0.76	10.02**
	16	IR 50404-57-2-2	-1.49**	18	IR48275-13-13-141-2	6.37**	-4.74**	-0.29	-1.34*
	17	IR 45461-129-3-3-3	-3.11**	19	IET 16310	3.84**	12.68**	-12.94**	-3.58**
	18	IR 48275-13-13-141-2	-2.24**	20	IET 16312	5.40**	-2.46**	-1.07	-1.88**
	19	IET 16310	7.33**	21	IET 16313	3.53**	0.61	-1.62*	-2.52**
	20	IET 16312	-1.53**	22	IR 29723-143-3-2-1	-1.14	-2.38**	1.45*	2.07**
	21	IET 16313	3.03**	23	IR 34686-179-1-2-1	2.70**	-2.71**	-5.88**	5.88**
	22	IR 29723-143-3-2-1	-3.21**	24	IR 56381-139-2-2	-1.88**	0.97	0.65	0.26
	23	IR 34686-179-1-2-1	5.13**	25	IR 38082-126-1-2	3.82**	-1.40*	0.16	-2.58**
	24	IR 56381-139-2-2	-5.97**						
	25	IR 38082-126-1-2	-0.98**						

*,** significant at 5% and 1% level of probability

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