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STUDIES ON HETEROBELTIOSIS AND STANDARD HETEROSIS FOR YIELD AND YIELD COMPONENT TRAITS IN RICE (*ORYZA SATIVA* L.) GROWN IN IRRIGATED SALINE LOW LAND OF TAMILNADU, INDIA

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Abstract

An experiment was conducted to estimate the heterosis for yield and yield attributing traits in rice. In the present investigation, line tester analysis involving eleven parents were used. The trail was conducted at Plant Breeding Farm, Faculty of Agriculture, Annamalai University during 2011. For grain yield per plant, the cross AURC 22 × ADT 43 observed lowest value of heterobeltiosis –27.60 per cent and standard heterosis –6.19 per cent, while the cross AURC 14 × TRY 1 recorded highest value of heterobeltiosis 34.74 per cent and standard heterosis 43.92 per cent. Among the hybrids, AURC 14 × TRY 1 and AURC 10 × ADT 43 were identified as superior hybrids as they recorded high magnitude of standard heterosis for number of productive tillers per plant, panicle length, filled grains per panicle, grain length, grain L/B ratio, kernel length, kernel L/B ratio and grain yield per plant. These heterosis will be exploited through selection of superior and trait specific genotypes in the segregating generations for the evolution of high yielding varieties.

Key words : Heterobeltiosis, standard heterosis, rice.

Introduction

Rice (*Oryza sativa* L.) is one of the worlds most important food crops and a primary source of food for more than half of the world population. In Asia, its main cultivation area, rice provides 35-60 per cent of the calories consumed. It is planted in about 163 million ha annually (FAO, 2013) of the worlds cultivated land (Degenkolbe *et al.*, 2013). Among the rice growing countries in the world, India has the largest area under rice crop (about 42.5 million ha, FAO, 2013) and ranks second in production next to China. Rice contributes 43 per cent of total food grain production and 46 per cent of total cereal production in India. Rice is the only crop in the world that is grown in most fragile ecosystem and hence, second green revolution is possible only if rice research is under taken vigorously. This in turn elucidates that we must reorient our research towards yield improvement. Exploitation of heterosis in rice has been considered as an important tool for breeding the present yield barriers. The study on the magnitude of heterosis is the most important prerequisite for under taking any heterosis breeding program (Saravanan *et al*., 2004). In the present investigation, an attempt was made to study the magnitude of heterosis for grain yield and important yield attributes is 30 intra specific crosses of rice.

Materials and Methods

Six lines *viz.,* AURC 1 (L_1), AURC 8 (L_2), AURC 10 (L_3), AURC 14 (L_4), AURC 22 (L_5) and AURC 25 (L_6) and five testers ADT 36 (T_1), ADT 39 (T_2), ADT 43 (T_3), IR 64 (T_4) and TRY 1 (T_5) and their thirty hybrids grown in randomized block design with three replications during *Kharif*, 2011 at plant breeding farm (11° 24¢ N latitude, 79°44¢E longitude and ± 5.79 m MSL), Faculty of Agriculture, Annamalai University located at east coastal region of Tamil Nadu, India with soil pH of 8 to 8.5 and EC of 2.51 to 2.81 dSm^{-1}, twenty five days old seedlings were transplanted in 3 m rows at a spacing of 20 × 15 cm between and within rows, respectively. All the recommended package of practices was followed to raise a good crop.

For this study, estimation of heterosis of yield traits *viz*., days to first flowering, plant height, number of productive tillers per plant, panicle length, filled grains

Table 1 : Analysis of variance for thirteen characters in rice.

Source	df	MSS												
		DF	**PH**	**NPT**	**PL**	**FGP**	**HGW**	**GL**	**GB**	**GLBR**	**KL**	**KB**	**KLBR**	**GYD**
Replication	2	2.6890	7.8849	0.9990	0.0061	41.5015	0.0011	0.0001	0.0210	0.0120	0.0103	0.0203	0.0018	0.1124
Hybrid	29	119.8103**	257.3107**	9.3302**	6.3560**	150.8746**	0.1286**	0.2550**	0.4076**	0.8277**	0.3250**	0.0073**	0.0975**	37.6092**
Line	5	105.2800**	568.0260**	3.0048**	1.4914**	162.9640**	0.4357**	0.7776**	1.0683**	2.2407**	1.1299**	0.0112**	0.2384**	5.2098**
Tester	4	497.1875**	780.3937**	21.2665**	3.2910**	438.5710**	0.3050**	0.6417**	1.3656**	2.7000**	0.6633**	0.0051**	0.2281**	136.7559**
L × T	20	47.9675**	75.0152**	8.5243**	8.1852**	90.3130**	0.0165**	0.0470**	0.0508**	0.0999**	0.0562**	0.0067**	0.0362*	25.8797**
Error	80	1.7265	1.1146	0.2320	0.1020	3.4880	0.0024	0.0001	0.0002	0.0011	0.0001	0.0013	0.0015	0.4686

* Significant at 5 per cent level, ** Significant at 1 per cent level

DF – Days to first flowering, **PH** – Plant height, **NPT** – Number of productive tillers per plant, **PL** – Panicle length, **FGP** – Filled grains per panicle, **HGW** – Hundred grain weight, **GL**-Grain length, **GB** – Grain breadth, **GLBR** – Grain L/B ratio, **KL** – Kernel length, **KB** – Kernel breadth, **KLBR** – Kernel L/B ratio, **GYD** – Grain yield per plant.

per panicle, hundred grain weight, grain length, grain breadth, grain L/B ratio, kernel length, kernel breadth, kernel L/B ratio and grain yield per plant were recorded of five randomly selected plants in each replication.

Results and Discussion

The analysis of variance showed significant differences among the hybrids, for all the thirteen traits *viz.,* days to first flowering, plant height, number of productive tillers per plant, panicle length, filled grains per panicle, hundred grain weight, grain length, grain breadth, grain L/B ratio, kernel length, kernel breadth, kernel L/B ratio and grain yield per plant. The analysis of variance showed significant differences among the lines, testers and their interaction effect L × T, for all the thirteen traits (table 1). The similar results was observed by Roy *et al.* (2009), Tiwari *et al.* (2011), Satheeshkumar (2011), Adityakumar *et al.* (2012) and Zeinab Montazeri *et al.* (2014).

Heterobeltiosis was negative, significant and maximum in L_1/T_1 for days to first flowering, while standard heterosis was negative and significant in thirty hybrids and it was ranged from –5.90 per cent (L_4/T_5) to –34.05 per cent (L_1/T_1) (table 2). For plant height the heterobeltiosis and standard heterosis was maximum negative and significant in L_3/T_3. For number of productive tillers per plant the heterobeltiosis was maximum positive and significant in L_5/T_5 and standard heterosis was maximum positive and significant in L_2/T_3. L_2/T_3 recorded highest positive significant values for heterobeltiosis and standard heterosis for panicle length. For hundred grain weight the standard heterosis was maximum positive and significant in L_5/T_5. For grain breadth the heterobeltiosis and standard heterosis was maximum negative and significant in L_3/T_5.

For kernel breadth the standard heterosis was negative and significant in thirty hybrids and it was ranged from –9.05 per cent (L_2/T_2) to –18.93 per cent (L_3/T_3). L_4/T_5 recorded maximum positive significant values for standard heterosis for filled grains per panicle, grain length, grain L/B ratio, kernel length and kernel L/B ratio. For grain yield per plant heterobeltiosis and standard heterosis was maximum, significant and positive in L_4/T_5 and eighteen hybrids recorded positive significant values for this trait.

Information on the magnitude of heterosis is the prerequisite in the development of hybrids. A good hybrid should manifest high amount of heterosis for commercial exploitation. Heterobeltiosis is a measure of hybrid vigour over the better parent. Bobby and Nadarajan (1994),

Table 2 : Estimates of heterosis for thirteen traits in rice.

Hybrids	DF		PH		NPT		PL		FGP		HGW	
	HB	SH	HB	SH	HB	SH	HB	SH	HB	SH	HB	SH
$L_1 \times T_1$	-32.60**	-34.05**	-7.96**	3.63**	-14.94**	36.67**	11.86**	14.29**	5.96**	8.25**	-15.32**	-14.20**
$L_1 \times T_2$	-6.56**	-7.57**	8.73**	-3.26**	6.29**	24.00**	1.26	11.06**	-9.90**	3.71**	-7.27**	-6.05**
$L_1 \times T_3$	9.23**	-23.24**	30.18**	-11.54**	-7.85**	48.67**	-9.17**	-6.45**	-11.60**	1.75	-17.46**	-16.37**
$L_1 \times T_4$	-12.71**	-14.59**	-15.62**	-6.48**	19.77**	37.33**	2.75**	11.75**	-2.02	12.78**	-6.81**	-5.58**
$L_1 \times T_5$	5.52**	-7.57**	-2.25**	10.07**	50.94**	60.00**	-2.01	0.92	-4.79**	9.59**	-5.99**	-4.76**
$L_2 \times T_1$	20.61**	-14.59**	28.88**	-2.34**	-2.07	57.33**	-4.55**	-3.23**	-7.84**	16.29**	-7.73**	-5.94**
$L_2 \times T_2$	-13.66**	-14.59**	15.35**	2.62**	14.67**	40.67**	-5.46**	3.69**	-18.71**	2.58	-15.75**	-14.11**
$L_2 \times T_3$	16.92**	-17.84**	34.51**	-8.60**	-0.41	60.67**	13.76**	15.21**	-6.13*	18.45**	-10.04**	-8.30
$L_2 \times T_4$	5.97**	-23.24**	15.82**	-2.02**	3.80	27.33**	-13.56**	-5.99**	-2.53**	22.99**	-6.77**	-4.96**
$L_2 \times T_5$	-12.43**	-12.43**	12.74**	12.74**	13.04**	38.67**	6.45**	6.45**	-12.01**	11.03**	-4.75**	-2.91**
$L_3 \times T_1$	-12.71**	-14.59**	-8.36**	-15.31**	-20.33**	28.00**	-8.14**	-6.45**	-2.12	9.28**	-3.60**	-22.38**
$L_3 \times T_2$	-6.08**	-8.11**	-9.75**	-16.60**	15.76**	42.00*	-7.14**	1.84	-7.20**	3.61**	-3.84**	-22.58**
$L_3 \times T_3$	-10.50**	-12.43**	-16.95**	-22.02**	-2.48	57.33**	11.76**	13.82**	5.91**	18.25**	-9.57**	-27.19**
$L_3 \times T_4$	-13.81**	-15.68**	1.69	-6.02**	2.17	25.33**	-9.32**	-1.38	-0.92	10.62**	-5.71**	-14.65**
$L_3 \times T_5$	-3.87**	-5.95**	9.95**	1.61*	13.04**	38.67**	2.71**	4.61**	13.48**	26.70**	-14.22**	-14.22**
$L_4 \times T_1$	-10.00**	-12.43**	2.70**	-14.39**	-12.03**	41.33**	10.91**	12.44**	21.13**	19.38**	-9.42**	-13.38**
$L_4 \times T_2$	-4.92**	-5.95**	-8.01**	-18.16**	32.57**	54.67**	-12.61**	-4.15**	11.56**	7.42**	-11.61**	-15.47**
$L_4 \times T_3$	18.46**	-16.76**	21.11**	-17.70**	-6.61**	50.67**	3.21**	3.69**	18.84**	14.43**	-16.39**	-20.04**
$L_4 \times T_4$	-16.67**	-18.92**	6.01**	-11.63**	11.05**	27.33**	-10.17**	-2.30	6.95**	7.94**	-6.57**	-10.65**
$L_4 \times T_5$	-3.33**	-5.90**	12.19**	-6.48**	36.05**	56.00**	7.37**	7.37**	27.73**	27.73**	-2.09**	-2.09**
$L_5 \times T_1$	11.45**	-21.08**	30.10**	-1.43	-13.69**	38.67**	8.64**	10.14**	4.73**	18.76**	-14.80**	1.32**
$L_5 \times T_2$	-9.29**	-10.27**	15.76**	2.99**	32.57**	54.67**	-7.14**	1.84	-3.09**	9.90**	-19.77**	-4.59**
$L_5 \times T_3$	10.77**	-22.16**	36.94**	-6.94**	-21.49**	26.67**	-5.94**	-5.07**	-2.82**	10.21**	-23.06**	-8.50**
$L_5 \times T_4$	2.99	-25.41	2.61**	-13.20**	27.91**	46.67**	-1.27	7.37**	2.55	16.29**	-15.15**	0.90**
$L_5 \times T_5$	-10.27**	-10.27**	0.51	0.51	52.00**	52.00**	7.76**	8.76**	6.64**	20.93**	-8.61**	8.68**
$L_6 \times T_1$	-12.05**	-21.08**	-10.90**	-5.29**	-20.33**	28.00**	-0.43	7.37**	-4.12**	15.26**	-7.97**	-8.39**
$L_6 \times T_2$	-9.29**	-10.27**	2.22**	-9.06**	14.86**	34.00**	-9.24**	-0.46	-13.46**	4.02**	-9.63**	-10.04**
$L_6 \times T_3$	9.23**	-23.24**	30.69**	-11.19**	-5.79**	52.00**	-9.83**	-2.76**	-11.41**	6.49**	-11.88**	-12.28**
$L_6 \times T_4$	-9.64**	-18.92**	-8.30**	-2.53**	14.29**	33.33**	-4.66**	3.69**	-15.27**	1.86	-1.06**	-1.51**
$L_6 \times T_5$	0.02	-10.27**	-1.82*	4.37**	31.43**	53.33**	0.85	8.76**	-0.69	19.38**	-0.61**	-0.61**

* Significant at 5 per cent level ; ** Significant at 1 per cent level.

DF – Days to first flowering, **PH** – Plant height, **NPT** – Number of productive tillers per plant, **PL** – Panicle length, **FGP** – Filled grains per panicle, **HGW** – Hundred grain weight, **GL**-Grain length, **GB** – Grain breadth, **GLBR** – Grain L/B ratio, **KL** – Kernel length, **KB** – Kernel breadth, **KLBR** – Kernel L/B ratio, **GYD** – Grain yield per plant, **HB** – Heterobeltiosis; **SH** – Standard heterosis.

Table 2 contd…

Hybrids	GL		GB		GLBR		KL		KB		KLBR		GYD	
	HB	SH	HB	SH	HB	SH	HB	SH	HB	SH	HB	SH	HB	SH
$L_1 \times T_1$	-0.86**	-0.62**	-1.63**	-1.95**	-1.85**	1.53**	0.50**	2.74**	-16.59**	-17.28**	20.65**	24.68**	17.54**	34.43**
$L_1 \times T_2$	-0.98**	-0.24**	-18.02**	-21.49**	-16.37**	27.20**	9.22**	-7.20**	-15.76**	-16.46**	-20.29**	11.71**	16.46**	25.99**
$L_1 \times T_3$	-1.22**	0.12**	-16.32**	-19.86**	-19.01**	25.67**	1.51**	3.77**	-14.93**	-15.63**	-25.56**	23.01**	-10.87**	-3.58
$L_1 \times T_4$	-6.04**	6.34**	-17.34**	-20.84**	-21.42**	34.86**	-1.51**	0.68**	-12.03**	-12.75**	-29.08**	16.31**	14.91**	24.31**
$L_1 \times T_5$	-1.74**	-1.74**	-0.65**	-0.65	-4.07**	-0.76**	0.83**	3.08**	-16.87**	-16.87**	20.65**	24.68**	26.61**	36.97**
$L_2 \times T_1$	1.86**	2.11**	-0.65**	-0.97**	2.26**	3.83**	0.83**	3.60**	-15.41**	-16.46**	19.67	24.68**	6.15**	21.41**
$L_2 \times T_2$	2.46**	3.23**	-21.59**	-23.12**	-11.08**	35.24**	-12.18**	-9.77**	-7.91**	-9.05**	-28.95**	-0.41**	5.48**	16.05**
$L_2 \times T_3$	5.03**	6.46**	-15.94**	-17.58**	-16.29**	29.88**	0.33**	3.08**	-15.83**	-16.87**	-24.55	24.68**	23.12**	35.46**
$L_2 \times T_4$	-6.15**	6.21**	-16.94**	-18.56**	-23.88**	30.65**	-2.00**	0.68**	-16.66**	-17.69**	-25.25**	22.59**	6.82**	17.53**
$L_2 \times T_5$	-1.86**	-1.86**	-1.62**	-1.62**	-1.13**	0.38**	0.16**	2.91**	-16.87**	-16.87**	19.27**	24.26**	24.10**	36.54**
$L_3 \times T_1$	-0.49**	-0.24**	-17.97**	-18.24**	-19.79**	22.60**	10.64**	3.43**	-0.49**	-16.87**	-21.78**	24.68**	-12.95**	17.98**
$L_3 \times T_2$	-0.86**	-0.12**	-1.47**	-34.52**	0.25**	53.25**	3.67**	-3.08**	32.45**	-17.69**	-25.72**	18.41**	5.80**	-1.87
$L_3 \times T_3$	-1.34**	0.01**	-0.99**	-33.87**	-0.49**	54.40**	4.70**	3.08**	35.86**	-18.93**	-23.03**	27.19**	32.85**	43.38**
$L_3 \times T_4$	-6.26**	6.09**	-0.98**	-34.52**	-5.13**	62.83**	0.67**	2.91**	30.92**	-18.10**	-22.95**	26.35**	-10.17**	21.75**
$L_3 \times T_5$	-0.62**	-0.62**	-33.87**	-35.17**	-1.00**	51.34**	2.91**	2.91**	-17.69	-17.69**	-21.25**	25.52**	3.24	39.92**
$L_4 \times T_1$	-5.70**	6.84**	-16.33**	-16.61**	-25.55**	28.35**	-0.77**	9.94**	0.98**	-15.63**	-22.44**	30.54**	19.36**	36.51**
$L_4 \times T_2$	-7.13**	5.22**	18.13**	-21.49**	-21.77**	34.86**	-7.12**	2.91**	35.76**	-15.22**	-38.32**	21.75**	6.01**	13.23**
$L_4 \times T_3$	-6.47**	5.97**	-2.02**	-34.52**	-5.55**	62.83**	0.77**	11.66**	32.66**	-18.10**	-23.95**	33.89**	-6.64**	-0.28
$L_4 \times T_4$	-1.20**	7.58**	0.49**	-33.55**	-1.77**	35.24**	1.36**	12.32**	31.57**	-17.69**	-23.90**	36.80**	13.13**	20.83**
$L_4 \times T_5$	-5.04**	11.94**	-20.19**	-20.19**	-21.55**	69.34**	1.39**	12.35**	-15.63**	-15.63**	-25.58**	36.82**	34.74**	43.92**
$L_5 \times T_1$	-5.21**	6.21**	6.20**	5.86**	-12.62**	0.76*	-9.81**	7.20**	-14.52**	-15.22**	5.57**	26.77**	-13.87**	20.33**
$L_5 \times T_2$	-6.21**	5.09**	-14.71**	-16.93**	-16.62**	26.81**	-7.64**	9.77**	-15.35**	-16.04**	6.26**	31.38**	-20.15**	11.54**
$L_5 \times T_3$	-5.43**	5.97**	-17.39**	-19.54**	-14.81**	32.18**	-8.22**	9.09**	-15.35**	-16.04**	-21.01**	30.54**	-27.60**	-6.19*
$L_5 \times T_4$	-4.94**	7.58**	-15.38**	-17.58**	-23.43**	31.41**	-7.35**	10.12**	-16.59**	-17.28**	-18.36**	33.89**	-12.08**	22.82**
$L_5 \times T_5$	-5.43**	5.97**	-1.30**	-1.30**	-6.31**	8.04**	-5.77**	12.00**	-12.75**	-12.75**	7.31**	28.87**	2.11	42.64**
$L_6 \times T_1$	-0.37**	-0.12**	-1.96**	-2.28**	-0.74**	2.68**	0.16**	2.23**	-13.41**	-17.69**	15.95**	24.68**	19.77**	36.98**
$L_6 \times T_2$	-0.61**	0.12**	-15.43**	-17.91**	-19.39**	22.60**	-6.72**	-4.80**	-13.41**	-17.69**	-17.01**	16.31**	4.63*	11.32**
$L_6 \times T_3$	0.61**	1.99**	-18.79**	-21.17**	-16.29**	29.88**	0.84**	2.91**	-13.41**	-17.69**	-24.05**	-25.52**	-4.17	1.96
$L_6 \times T_4$	-6.15**	6.21**	-18.12**	-20.52**	-21.65**	34.48**	-5.03**	-2.91**	-13.85**	-18.10**	-27.55**	18.82**	13.52**	20.78**
$L_6 \times T_5$	-0.37**	-0.24	-1.62**	-1.62**	-1.48**	1.91**	1.17**	3.77**	-18.51**	-18.51**	18.28	27.19**	30.71**	39.06**

* Significant at 5 per cent level, ** Significant at 1 per cent level.

DF – Days to first flowering, **PH** – Plant height, **NPT** – Number of productive tillers per plant, **PL** – Panicle length, **FGP** – Filled grains per panicle, **HGW** – Hundred grain weight, **GL**- Grain length, **GB** – Grain breadth, **GLBR** – Grain L/B ratio, **KL** – Kernel length, **KB** – Kernel breadth, **KLBR** – Kernel L/B ratio, **GYD** – Grain yield per plant, **HB** – Heterobeltiosis; **SH** – Standard heterosis.

Satheeshkumar (2005), Vaithiyalingan and Nadarajan (2010), Krishna *et al*. (2011), Latha *et al*. (2013) and Ammar Gholizadeh Ghara *et al*. (2014) stressed the need for computing standard heterosis for commercial exploitation of hybrid vigour. Hene, for the evaluation of hybrids, standard heterosis is to be given more importance rather than heterobeltiosis.

The hybrids L_4/T_5 and L_3/T_3 exhibited highly significant and positive values for grain yield per plant in standard heterosis. They also recorded significant and positive standard heterosis for the traits *viz.,* number of productive tillers per plant, panicle length, filled grains per panicle, grain length, grain L/B ratio, kernel length and kernel L/B ratio. The hybrids L_5/T_4 and L_5/T_5 showed significant and positive standard heterosis for nine other characters. The hybrids L_1/T_4, L_2/T_3, L_3/T_3, L_4/T_1 and L_4/T_5 also showed significant and positive standard heterosis for eight other traits. Hence, it may be concluded that, L_4/T_{5-} and L_3/T_3 can be rated as best hybrids and the hybrids L_1/T_4, L_2/T_3, L_4/T_1, L_5/T_4 and L_5/T_5 can be rated as better hybrids based on the magnitude of heterosis.

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