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Genotype x environment interaction in scented rice

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ABSTRACT

Genotypes x environment interaction was studied for grain yield, its components and grain quality traits in 10 parents and their 45 F_1s of scented rice (Oryza sativa L.) under four environments created by four different dates of transplanting during wet season 2003. Significant genotype x environment interactions were observed for all the eleven characters having homogenous error variance in environments. Among the linear and non-linear components of G x E interaction linear component was predominant for most of the characters, suggesting variation in the performance of different genotypes grown over environments could be predicted. Mean squares due to environment (linear) was also found significant for all the characters, indicating differences between environments and their influence on genotypes for expression of these characters. Based on stability parameters and overall mean, genotypes IET 13549 and Pusa Basmati-1 were most stable under different environments, while IET 13846 was suitable for poor environments and the crosses Taroari Basmati x IET 16320, IET 13549 x IET 13846 and Pusa Basmati-1 x IET 13846 were more suitable for favourable environments with respect to these characters.

Key words: *Scented rice, stability parameters, grain yield, grain quality characters*

The genotype x environment (G x E) interaction is a limitation in most plant breeding programmes aiming at improvement of quantitative attributes like yield. The occurrence of G x E interaction has provided a challenge for better understanding of genetic control of variability and thus to rationalize procedures for breeding improved genotypes in crop plants (Breese, 1969). These interactions are usually present under all conditions including pure lines, single cross or double cross hybrids, top crosses, S_1 lines and any other material used for breeding (Eberhart and Russell, 1966). In this context, it is necessary to pay attention in reducing and characterizing the G x E interaction and in controlling it, so as to develop genotypes with desired response at varying environmental conditions. Keeping this in view, the present investigations was carried out to examine the genotype x environment interactions for identifing quantitative and qualitative traits and high yielding stable genotypes of scented rice.

MATERIALS AND METHODS

The experimental material for the present investigation consisted of fifty-five genotypes including ten parents *viz.*, Taroari Basmati, Basmati 370, Pakistani Basmati, IET 16320, IET 13549, Pusa Basmati-1, Mahi Sugandha, IET 13846, Kasturi and Haryana Basmati-1 and their forty-five crosses. The crosses were made by inter mating ten parents in diallel fashion (without reciprocals). All the fifty-five genotypes (45 F_1s and 10 parents) were evaluated in randomized block design with three replications at the Agricultural Research Station, Kota (Rajasthan) during wet season 2003 under four contrasting environments, created by four different dates of transplanting *viz.*, E_1 25th June (early transplanting time), E_2 10th July (normal transplanting time), E_3 25th July (late transplanting time) and E_4 10th August (very late transplanting time). Single seedling of 25 days old hill^{-1} was transplanted in a single row plot of 3.0 meter length with 20 cm and 15 cm inter and intra row spacing, respectively. Recommended agronomic practices and plant protection measures were adopted for raising a healthy crop. The observations were recorded on ten randomly selected competitive plants of each treatment in each replication for 18 characters *viz.*, days to 50% flowering, plant height, number of panicles plant^{-1}, panicle length, number of grains panicle^{-1}, spikelet sterility, 1000-grain weight, biological yield plant^{-1}, harvest index, grain yield plant^{-1}, hulling percentage, milling percentage, head rice recovery, kernel length, kernel breadth, L/B ratio, kernel length after cooking and elongation ratio. Statistical analysis on different stability parameters were carried out following Eberhart and Russell (1966) model.

RESULTS AND DISCUSSION

Bartlett's test was non-significant for days to 50% flowering, plant height, panicle length, spikelet sterility, biological yield plant^{-1}, harvest index, grain yield plant^{-1}, hulling percentage, milling percentage, head rice recovery and kernel length, showing homogeneity of error variance. Therefore, stability parameters have been estimated and discussed for these eleven characters only. The analysis of variance (Table 1) revealed that mean squares due to genotypes were highly significant for all the characters studied, indicating presence of genetic variability in the experimental material. The genotype x environment mean squares were significant for all the characters, indicating the differential response of genotypes in different environmental conditions. Mishra and Dash (1997), Kandhola and Panwar (1999), Swamy and Kumar (2003) and Senapati and Sarkar (2004) also reported significant genotype x environment interactions for grain yield and its components. Linear component of environment was significant for all the characters, indicating that the environments tested differed significantly. G x E (linear) was significant for all the characters, indicating that there was significant difference in regression coefficient of genotypes over different dates of transplanting. Significance of G x E (linear) for the characters days to 50% flowering and head rice recovery was in conformity with the earlier reports of Mishra and Dash (1997) and Vidhu Francis *et al.* (2005). Higher magnitude of environment (linear) effect in comparison to G x E (linear) may be responsible for high adaptation in relation to grain yield and other traits (Rai *et al.*,1989). Non-linear components of G x E interaction was significant for all the characters, confirming the findings of Singh *et al.* (1997) and Shadakshari *et al.* (2001).

A perusal of stability parameters for grain yield plant^{-1} indicated that out of fifty-five genotypes, 21 genotypes (5 parents and 16 crosses) exhibited non-significant deviation from regression (S^2d_i), indicating their predictable performance. Out of these, 3 parents exhibited mean values higher than parental mean and 3 crosses had mean values greater than the best parent, Pusa Basmati-1.

Parent P_8 (IET 13846) had regression coefficient less than unity (b_i<1), indicating its suitability for unfavourable environments, whereas parents P_5 (IET 13549) and P_6 (Pusa Bsamati-1) had regression coefficient around unity (b_iH”1), hence suitable for any unpredictable environment for higher grain yield plant^{-1} (Table 2). All the three crosses *viz.*, Taroari Basmati x IET 16320, IET 13549 x IET 13846 and Pusa Basmati-1 x IET 13846 were below average

Table 1. Analysis of variance for stability parameters (Eberhart and Russell, 1966) in scented rice

Characters	Genotype	G x E	E+(G x E)	E (Linear)	G x E (Linear)	Pooled deviation	Pooled Error
	[54]	[162]	[165]	[1]	[54]	[110]	[432]
Days to 50% flowering	81.45**	35.00**	60.62**	8113.16**	16.61**	9.02**	2.93
Plant height	304.97**	81.62**	76.70**	8247.99**	31.33**	24.68**	2.64
Panicle length	29.86**	6.08**	3.84**	305.15**	2.81**	1.60**	0.41
Spikelet sterility	36.43**	12.51**	6.73**	435.68**	5.05**	3.66**	0.22
Biological yield plant^{-1}	654.20**	101.55**	198.43**	27257.42**	57.13**	21.80**	6.06
Harvest index	72.57**	23.85**	13.86**	999.61**	8.07**	7.74**	3.38
Grain yield plant^{-1}	225.09**	41.86**	55.84**	6953.61**	27.12**	7.23**	0.73
Hulling percentage	65.30**	13.10**	16.34**	1989.61**	4.91**	4.02**	2.85
Milling percentage	43.11**	8.32**	21.77**	3054.38**	2.97*	3.43**	2.03
Head rice recovery	32.26**	10.52**	23.53**	3314.46**	4.34**	3.03**	1.58
Kernel length	0.25**	0.25**	0.15**	11.87**	0.07**	0.08**	0.02

*,** Significant at 5% and 1% level, respectively

Table 2. Mean performance and stability parameters in scented rice genotypes for 11 characters in four environments

Genotype	Days to 50% flowering			Plant height			Panicle length		
	μ_i	b_i	S^2d_i	μ_i	b_i	S^2d_i	μ_i	b_i	S^2d_i
P_1	100.33	1.24**	-1.41	123.01	1.05	15.40**	23.85	0.34	0.62
P_2	100.42	1.08*	-0.08	118.39	1.17*	6.25*	22.60	0.27	0.17
P_3	102.33	1.00**	-2.28	125.11	1.23	78.50**	21.16	1.48	2.23**
P_4	99.67	0.54	3.35	100.27	1.03	17.70**	24.69	1.00*	-0.14
P_5	98.75	0.85*	1.70	95.23	1.14	11.90**	24.61	-0.00	-0.11
P_6	97.58	0.95**	-1.69	99.64	0.77	13.00**	25.39	0.62	-0.28
P_7	100.67	0.87**	-2.22	105.41	0.33	12.90**	22.02	0.96	2.04**
P_8	98.00	1.02	5.52	97.14	0.96	27.40**	24.44	0.51*+	-0.38
P_9	95.92	0.73*	-0.46	100.70	0.44	12.20**	22.38	0.41	0.19
P_{10}	91.83	1.12**	-2.57	93.62	1.13	15.80**	19.82	-0.07	0.74
P_1 x P_2	100.75	0.93**	-1.67	113.63	0.71	6.34*	26.81	-0.48	0.67
P_1 x P_3	102.42	1.15*	-0.07	116.77	1.43**+	-1.96	21.83	0.77	1.90**
P_1 x P_4	96.08	1.40*	3.52	107.15	1.08	40.30**	25.97	0.80	0.16
P_1 x P_5	93.00	0.73**+	-2.60	93.07	1.76*	11.30**	26.85	0.92	4.10**
P_1 x P_6	96.75	1.04**	-1.81	105.06	0.70	6.82*	26.61	1.09*	-0.06
P_1 x P_7	102.83	1.32*	0.78	111.03	0.38	7.43*	24.18	1.87	7.05**
P_1 x P_8	98.50	1.15*	5.54	96.75	0.19	52.50**	25.20	0.60	0.43
P_1 x P_9	89.08	1.14**	-2.52	100.35	0.66	16.40**	24.24	0.37	1.47*
P_1 x P_{10}	91.25	1.66**+	0.36	99.80	0.51	44.20**	23.20	0.12	1.52**
P_2 x P_3	99.67	1.13**	-2.39	116.20	2.18**+	1.21	22.55	1.28	0.79
P_2 x P_4	97.92	0.29	11.90**	103.88	0.40	77.10**	27.46	1.59*	0.07
P_2 x P_5	99.58	1.42*	2.96	91.66	0.79*	1.91	26.62	0.17+	-0.29
P_2 x P_6	90.92	0.76*	1.33	103.87	0.64	9.18*	27.94	1.80*	0.13
P_2 x P_7	100.17	1.02*	2.90	106.24	1.11	53.80**	20.26	0.09	1.42*
P_2 x P_8	89.17	1.22**	-1.87	97.35	0.92	51.70**	27.15	0.77*	-0.362
P_2 x P_9	97.75	1.52	25.30**	108.59	1.33	30.50**	22.40	2.43	3.23**
P_2 x P_{10}	91.17	0.95	6.30*	95.39	1.77*	15.20**	23.54	1.85**++	-0.40
P_3 x P_4	101.58	0.90	8.96*	103.21	-0.01	53.80**	24.36	1.33	1.66**
P_3 x P_5	100.08	0.60*+	-2.34	94.52	1.02	37.50**	27.18	1.55	1.83**
P_3 x P_6	102.08	0.83	2.62	106.14	0.89	4.96	24.89	1.09	0.61
P_3 x P_7	100.25	1.28*	0.03	115.27	1.49*	3.74	25.60	3.00	2.80**
P_3 x P_8	89.58	1.09*	1.62	97.50	0.63	16.00**	25.50	0.13	0.38
P_3 x P_9	95.17	1.47	57.90**	107.47	2.02**++	-1.93	19.38	1.19	1.48*
P_3 x P_{10}	98.50	1.29*	0.86	96.45	1.66*	5.71*	20.29	1.07	0.18
P_4 x P_5	89.75	0.58	15.80**	89.54	0.86**	-2.21	28.60	1.33**	-0.36
P_4 x P_6	96.67	1.13**	-1.22	94.22	0.48	41.20**	25.66	0.81	0.27
P_4 x P_7	101.33	0.29	72.70**	105.05	1.22*	0.354	25.60	1.70	0.69
P_4 x P_8	94.08	1.02	13.50**	89.09	1.16**	-1.55	24.53	2.25	2.93**
P_4 x P_9	92.92	1.66*	10.60*	100.17	0.83	50.60**	21.74	1.82**+	-0.33
P_4 x P_{10}	88.00	1.40	21.70**	93.63	0.06	24.30**	20.28	0.24	1.26*
P_5 x P_6	96.58	1.03*	5.06	103.42	1.12	24.10**	27.13	1.57*	-0.08
P_5 x P_7	100.58	0.89**	-2.03	100.59	1.28	23.40**	23.32	1.93	4.73**
P_5 x P_8	93.00	0.79*	0.51	87.91	1.02**	-1.73	28.50	0.94	0.27
P_5 x P_9	100.08	0.53	9.63*	92.46	0.75	23.90**	18.13	0.38	1.48*
P_5 x P_{10}	96.58	0.21	16.00**	91.69	1.70	39.90**	19.44	1.72	2.89**
P_6 x P_7	105.08	0.88*	-1.69	104.18	1.20*	6.02*	25.89	0.50	1.13*
P_6 x P_8	94.50	1.24**	-2.39	101.46	0.83	36.10**	26.80	0.87	1.67**
P_6 x P_9	100.58	0.42	11.90**	95.89	1.10	12.00**	26.25	1.50*	-0.21
P_6 x P_{10}	90.08	0.67	26.20**	96.21	1.01	81.70**	20.86	0.85	1.38*
P_7 x P_8	100.50	0.86**	-2.64	94.02	1.49	54.80**	26.15	0.72	2.90**
P_7 x P_9	100.67	1.36**	-1.43	104.64	1.20*	4.12	20.64	1.85	3.74**
P_7 x P_{10}	93.25	1.51**++	-2.91	105.76	0.81	24.90**	22.05	1.13	4.98**
P_8 x P_9	102.17	0.79	11.10**	90.38	0.93	11.40**	23.27	0.22	0.53
P_8 x P_{10}	88.08	1.01	14.40**	87.69	1.04*	2.07	17.82	0.25	-0.10
P_9 x P_{10}	92.00	1.07*	2.95	98.55	1.38*	2.07	22.41	1.50*	0.05

*,** b_i and S^2d_i significant at 5% and 1% level, respectively
+,++ b_i is significantly deviating from unity at 5% and 1% level, respectively

Genotype	Spikelet sterility			Biological yield plant^{-1}			Harvest index		
	μ_i	b_i	S^2d_i	μ_i	b_i	S^2d_i	μ_i	b_i	S^2d_i
P_1	16.21	0.57	1.01**	72.42	0.84*	3.40	28.92	0.62	-1.84
P_2	17.16	0.95	2.25**	65.62	0.82*	7.16	30.58	0.78	0.35
P_3	20.14	1.73	3.18**	64.24	0.53	3.09	27.95	0.64	-1.87
P_4	17.93	0.45	0.20	82.01	0.52**++	-5.92	36.07	0.32	1.56
P_5	17.76	1.20	0.66*	83.60	1.11	28.70**	37.53	1.05	-1.68
P_6	17.79	0.91	0.38	84.88	0.80**	-4.11	41.08	0.72	-1.31
P_7	22.55	1.36	1.55**	66.31	0.98*	7.95	29.95	0.98	4.77
P_8	19.46	0.82	1.74**	77.38	0.74	10.80	31.78	0.36	0.47
P_9	21.54	1.30	3.46**	66.82	0.69*	-1.61	34.01	0.21	8.16*
P_{10}	23.41	0.30+	-0.12	61.23	0.94*	12.00	31.59	1.60*	-1.31
$P_1 \times P_2$	16.45	0.68	1.31**	69.62	0.87*	9.90	36.29	1.28	-1.51
$P_1 \times P_3$	20.91	1.28	3.49**	76.63	0.50	7.60	31.99	2.05	27.20**
$P_1 \times P_4$	16.06	1.57*	0.60*	84.16	0.80*	9.02	44.78	1.64	13.70**
$P_1 \times P_5$	14.30	0.39	1.34**	101.10	1.27	46.40**	40.31	2.33*	-1.50
$P_1 \times P_6$	14.57	0.62	-0.01	95.33	1.41**	0.66	39.90	1.25	8.12*
$P_1 \times P_7$	20.22	2.91*	1.74**	74.47	1.52*	30.40**	37.15	0.32+	-3.04
$P_1 \times P_8$	13.88	1.67*	0.32	66.04	0.97**	-5.06	40.56	0.68	31.10**
$P_1 \times P_9$	17.23	3.42**++	-0.08	83.41	0.66*	1.66	40.09	-0.35	3.61
$P_1 \times P_{10}$	19.54	1.32	0.98**	60.94	0.77	23.60**	37.75	0.69	-0.02
$P_2 \times P_3$	17.98	0.87	3.18**	57.49	0.51*+	-4.45	33.82	1.29**	-3.30
$P_2 \times P_4$	15.07	1.08	5.99**	65.71	0.82*	3.61	38.91	0.46	-2.52
$P_2 \times P_5$	14.30	1.01	0.78*	80.13	1.05*	6.92	42.24	1.07	-1.29
$P_2 \times P_6$	20.15	1.78	1.24**	101.45	1.37	141.00**	41.64	1.54	-0.32
$P_2 \times P_7$	12.90	1.28	3.66**	67.17	0.96*	1.21	37.00	1.68*	-2.10
$P_2 \times P_8$	18.38	0.49	1.21**	88.19	1.13*	4.08	42.24	2.59*	2.64
$P_2 \times P_9$	20.04	0.08	1.06**	71.31	0.94*	6.13	31.99	0.23	4.67
$P_2 \times P_{10}$	15.85	1.20**	-0.14	61.88	0.84*	6.17	33.48	1.30	-0.34
$P_3 \times P_4$	21.12	0.51	1.39**	75.28	0.37	6.85	40.72	0.87	-2.54
$P_3 \times P_5$	15.21	0.65	1.38**	75.07	0.88*	-0.98	37.17	1.25	-0.94
$P_3 \times P_6$	15.44	1.13*	0.01	100.13	1.31*	21.60*	38.70	1.05	3.81
$P_3 \times P_7$	15.21	2.13	3.35**	89.91	1.53*	8.93	38.26	1.65	2.64
$P_3 \times P_8$	19.41	1.99	8.75**	70.47	1.29*	23.40**	39.31	0.63	1.29
$P_3 \times P_9$	17.26	0.96	7.51**	63.15	0.64*	-1.50	32.86	0.41	-1.09
$P_3 \times P_{10}$	16.30	0.24	6.64**	73.55	1.53**+	-0.31	32.22	1.60*	-1.50
$P_4 \times P_5$	12.59	0.53	1.67**	100.03	1.59**+	-3.87	43.50	1.14	18.60**
$P_4 \times P_6$	12.45	1.33	1.25**	103.61	1.56*	22.60**	40.86	1.83	1.70
$P_4 \times P_7$	20.03	0.76	7.69**	65.69	0.34	33.10**	42.15	0.63	-1.74
$P_4 \times P_8$	12.07	0.40	0.72*	97.09	1.43**	2.81	43.13	1.91	10.00*
$P_4 \times P_9$	14.97	0.55	14.20**	72.17	0.89	56.40**	36.94	0.59	-0.52
$P_4 \times P_{10}$	18.14	0.78	18.70**	68.92	0.80**	-4.31	34.41	-0.59	23.60**
$P_5 \times P_6$	12.60	0.47	0.60*	99.85	1.42*	26.50**	42.86	1.83	0.10
$P_5 \times P_7$	15.04	-0.36	3.28**	78.72	1.09*	9.57	36.09	0.63	4.86
$P_5 \times P_8$	10.83	0.92	0.75*	90.61	1.28*	5.54	41.45	0.57	2.57
$P_5 \times P_9$	15.61	0.74	6.89**	82.90	1.62	79.60**	35.41	1.60	63.90**
$P_5 \times P_{10}$	18.26	-1.03**++	-0.17	80.45	1.25*	17.60*	42.90	0.75	-0.23
$P_6 \times P_7$	15.26	1.53	2.65**	65.33	0.51	1.59	39.01	0.51	-0.08
$P_6 \times P_8$	11.60	1.66*	0.19	89.62	1.24*	8.59	43.65	1.62	3.35
$P_6 \times P_9$	17.85	1.23	18.40**	69.58	1.05	94.70**	37.45	-0.35+	-2.87
$P_6 \times P_{10}$	20.07	0.17	1.02**	74.73	1.24	45.60**	33.27	0.53	6.43
$P_7 \times P_8$	21.03	-0.81	7.77**	74.56	0.99*	5.85	33.59	1.15	-1.48
$P_7 \times P_9$	18.08	3.01	23.50**	58.27	0.61	17.80*	34.26	0.42	0.65
$P_7 \times P_{10}$	12.95	0.71	4.73**	61.87	0.76**+	-5.66	32.01	0.63	-2.40
$P_8 \times P_9$	12.32	1.02	0.63*	91.40	1.18	42.10**	40.08	1.65	3.65
$P_8 \times P_{10}$	17.06	1.00	3.76**	81.74	1.31**	-0.68	37.03	1.82*	-0.15
$P_9 \times P_{10}$	17.44	1.53	0.89**	65.32	0.91*	1.51	35.06	1.34	25.90**

*,** b_i and S^2d_i significant at 5% and 1% level, respectively
+,++ b_i is significantly deviating from unity at 5% and 1% level, respectively

Genotype	Grain yield plant^{-1}			Hulling percentage			Milling percentage		
	μ_i	b_i	S^2d_i	μ_i	b_i	S^2d_i	μ_i	b_i	S^2d_i
P_1	20.97	0.62**++	-0.64	75.00	0.75	3.94	67.65	0.92*	-0.17
P_2	20.16	0.60	5.83**	73.99	0.62	1.01	66.07	1.10*	-0.69
P_3	17.97	0.44*+	0.12	70.43	0.25	-0.77	63.59	0.48	0.39
P_4	29.60	0.55	2.79**	74.11	0.68**+	-2.81	67.18	0.73*	-1.20
P_5	31.38	0.97*	0.78	74.34	1.06	1.22	66.94	1.00	4.20*
P_6	34.96	0.92**	0.19	73.40	1.24	1.09	65.86	1.04*	0.99
P_7	19.98	0.85*	1.63*	67.95	0.59	5.80*	60.35	0.47	5.86*
P_8	24.61	0.64**+	-0.54	69.36	0.76	0.14	63.48	0.46	1.58
P_9	22.67	0.43	9.36**	71.60	0.76	4.51	65.23	1.35*	3.14
P_{10}	19.58	0.94*	4.92**	68.07	0.90	10.70**	61.48	0.94	25.50**
P_1 x P_2	25.39	0.97**	0.40	80.84	0.64	-1.01	71.25	1.15**	-1.53
P_1 x P_3	24.38	0.63	16.1**	80.88	1.67*	-0.19	71.88	0.78	7.11*
P_1 x P_4	37.95	1.34**	0.70	76.63	1.08**	-2.73	66.28	1.16*	0.15
P_1 x P_5	41.08	1.77*	4.66**	79.09	0.63	-1.97	68.52	1.39*	2.04
P_1 x P_6	38.09	1.46*	5.04**	76.79	0.92**+	-2.85	68.02	0.43*++	-1.86
P_1 x P_7	27.64	1.22**	-0.11	74.63	1.35*	-1.58	64.20	0.98*	-1.32
P_1 x P_8	26.74	0.76	17.60**	75.37	1.58**+	-2.57	64.56	1.01*	-0.87
P_1 x P_9	33.32	0.38	9.73**	70.62	1.42	3.94	63.52	0.91**	-1.60
P_1 x P_{10}	22.95	0.73	8.79**	69.86	1.35*	-0.71	63.61	0.99**	-1.85
P_2 x P_3	19.48	0.58*+	-0.02	83.64	1.40*	0.58	71.98	0.87	0.88
P_2 x P_4	25.62	0.77**+	-0.41	78.96	1.37*	-2.00	67.98	1.12	2.55
P_2 x P_5	34.04	1.23**	0.20	79.21	0.69	0.50	68.41	1.02**	-1.79
P_2 x P_6	42.40	1.55	30.60**	77.36	1.03*	-2.26	68.54	1.10**	-1.93
P_2 x P_7	25.16	1.13**	0.59	76.71	0.46*+	-2.53	66.08	1.13*	-0.58
P_2 x P_8	37.67	1.73*	8.22**	77.47	1.28	2.16	67.62	1.03*	-1.13
P_2 x P_9	22.72	0.54	9.06**	75.71	1.20*	-1.33	65.16	0.97**	-1.93
P_2 x P_{10}	20.93	0.87*	1.52*	67.24	1.18	0.66	59.73	0.95	1.90
P_3 x P_4	30.64	0.51	3.55**	79.28	1.51*	0.20	66.13	1.22*	-0.92
P_3 x P_5	28.13	1.02*	0.62	76.36	1.66	27.80**	69.72	1.01*	-0.01
P_3 x P_6	38.98	1.42	16.90**	76.38	1.41*	-1.64	66.73	1.10**	-1.70
P_3 x P_7	34.76	1.66*	8.72**	72.84	1.34*	-2.00	62.98	1.05**	-1.49
P_3 x P_8	27.90	1.28**	-0.15	79.06	0.88	0.30	67.45	0.99**	-1.75
P_3 x P_9	20.75	0.48	1.14	67.39	0.82	0.37	61.33	1.00	2.83
P_3 x P_{10}	23.93	1.29**+	-0.54	68.48	1.41*	-1.48	62.50	1.04**	-1.60
P_4 x P_5	44.07	1.97	28.10**	74.62	1.32**+	-2.75	67.95	0.66*	-1.53
P_4 x P_6	42.45	1.72*	5.35**	75.13	1.12**	-2.75	68.99	1.24	2.79
P_4 x P_7	27.73	0.50	9.54**	64.52	1.55*	0.34	58.47	1.24*	-0.66
P_4 x P_8	42.38	1.95**+	3.58**	75.98	0.98**	-2.56	68.22	0.64**++	-1.98
P_4 x P_9	26.58	0.67	4.21**	71.28	1.17*	-2.10	62.51	1.02*	-0.76
P_4 x P_{10}	23.36	0.18	3.97**	68.53	1.29*	-2.22	62.42	0.94*	-0.92
P_5 x P_6	43.23	1.84*	18.80**	78.56	1.09	11.80**	68.00	1.09*	-0.08
P_5 x P_7	28.41	0.86	6.54**	76.42	0.18	21.00**	63.02	1.06*	-0.38
P_5 x P_8	37.73	1.36**	1.23	71.88	1.24*	-2.13	64.94	1.00**	-2.02
P_5 x P_9	29.07	1.08	46.60**	75.89	1.01**	-2.82	61.79	0.88	2.15
P_5 x P_{10}	34.72	1.35**	0.60	76.13	0.47	-0.45	65.57	1.27	15.90**
P_6 x P_7	25.47	0.52	3.59**	75.41	0.86**	-2.81	67.62	1.42	6.82*
P_6 x P_8	39.48	1.61**+	1.24	70.62	0.78	6.21*	60.37	1.03*	-0.01
P_6 x P_9	25.91	0.70	11.30**	79.97	1.18*	-0.20	68.52	0.62*	-1.54
P_6 x P_{10}	24.79	0.75	15.60**	77.08	0.63	3.39	68.33	1.07*	-0.29
P_7 x P_8	25.13	0.88*	1.49*	70.48	0.32**++	-2.86	62.11	1.06*	-0.06
P_7 x P_9	20.03	0.49	7.10**	73.40	0.81**	-2.65	65.67	1.24*	0.50
P_7 x P_{10}	19.87	0.63*+	-0.16	73.77	0.60*	-2.43	57.31	0.90*	-0.00
P_8 x P_9	36.76	1.36*	7.06**	74.93	0.65	2.06	65.08	1.35	12.50**
P_8 x P_{10}	30.82	1.53**++	-0.52	73.06	0.96*	-2.27	65.65	1.34	11.00**
P_9 x P_{10}	22.95	0.76	15.00**	75.45	0.88	15.80**	67.89	1.03	2.61

*,** b_i and S^2d_i significant at 5% and 1% level, respectively
+,++ b_i is significantly deviating from unity at 5% and 1% level, respectively

Genotype	Head rice recovery			Kernel length		
	μ_i	b_i	S^2d_i	μ_i	b_i	S^2d_i
P_1	50.19	1.22**	-1.06	7.11	0.74*	-0.01
P_2	50.12	1.10*	1.42	7.03	0.57	0.01
P_3	47.44	1.16	5.66*	6.80	1.58*	0.00
P_4	49.98	0.96*	-0.51	6.94	0.85	-0.01
P_5	50.33	1.34*	2.03	6.94	1.08	-0.00
P_6	48.61	0.51	1.10	7.13	0.65	-0.00
P_7	46.73	0.46	2.45	6.66	0.59	-0.00
P_8	46.61	0.82	15.30**	6.77	0.68**++	-0.02
P_9	46.55	0.78	5.70*	6.75	1.07*	-0.01
P_{10}	48.18	0.74	1.21	6.69	1.32	0.01
P_1 x P_2	51.62	1.15*	-0.28	7.59	0.88	-0.01
P_1 x P_3	52.19	1.06*	-0.81	7.41	1.51*	-0.01
P_1 x P_4	52.93	0.71	4.35*	6.76	0.89	0.02
P_1 x P_5	50.10	1.19**	-0.76	7.07	0.20	0.13**
P_1 x P_6	51.67	1.17	3.98*	7.03	1.13*	-0.01
P_1 x P_7	48.62	1.06**	-1.51	6.68	0.32	0.00
P_1 x P_8	50.50	0.93**	-1.38	6.66	0.20	-0.01
P_1 x P_9	48.95	-0.04	2.17	6.93	0.89	0.02
P_1 x P_{10}	47.56	1.08**	-0.97	7.05	0.98	0.06*
P_2 x P_3	52.33	1.32	12.40**	7.33	1.52*	-0.01
P_2 x P_4	51.47	1.04	10.10**	6.60	0.96	0.15**
P_2 x P_5	51.32	1.04**	-0.96	7.10	-0.07	-0.00
P_2 x P_6	53.85	0.85	7.35**	6.70	0.65	0.04
P_2 x P_7	49.89	1.01**	-1.37	6.54	-0.72+	0.00
P_2 x P_8	50.71	1.35*	2.36	7.21	0.71	0.10**
P_2 x P_9	47.09	1.01**	-1.49	6.84	1.37	0.09**
P_2 x P_{10}	43.95	0.94*	0.71	7.16	0.68	0.12**
P_3 x P_4	48.12	1.02**	-1.50	7.05	-0.35	0.02
P_3 x P_5	51.29	0.97**	-1.28	6.96	0.57	0.17**
P_3 x P_6	51.21	1.39*	0.88	7.20	1.33	0.25**
P_3 x P_7	46.74	0.93**	-1.46	6.76	1.66	0.04*
P_3 x P_8	50.60	1.03**	-1.53	7.10	1.97	0.11**
P_3 x P_9	45.11	0.95*	-0.62	6.46	1.28	0.04
P_3 x P_{10}	49.57	1.22	11.60**	7.03	2.08*	0.00
P_4 x P_5	54.16	1.24	4.50*	7.03	1.34	-0.00
P_4 x P_6	49.99	0.97**	-1.28	7.45	1.29	0.05*
P_4 x P_7	42.88	0.82	5.07*	6.81	0.96*	-0.01
P_4 x P_8	52.45	0.45+	-0.71	6.86	1.88	0.01
P_4 x P_9	46.64	0.95**	-1.45	7.19	2.13	0.11**
P_4 x P_{10}	46.16	0.95**	-1.30	6.99	0.42	0.23**
P_5 x P_6	53.63	1.51*	1.40	7.30	0.34	0.05*
P_5 x P_7	46.75	0.95**	-1.40	6.91	1.44**	-0.01
P_5 x P_8	47.86	0.98**	-1.24	6.58	0.12	0.05*
P_5 x P_9	50.10	1.18*	0.47	6.96	1.56	0.10**
P_5 x P_{10}	48.80	1.04**	-1.08	6.68	1.98*	0.00
P_6 x P_7	53.20	0.85	1.93	7.16	1.22	0.15**
P_6 x P_8	47.45	1.17**+	-1.55	6.90	0.90	0.08**
P_6 x P_9	52.53	1.50*	1.89	7.05	1.19	0.18**
P_6 x P_{10}	55.49	1.00*	0.39	7.00	1.22	0.19**
P_7 x P_8	46.47	0.93**	-1.55	6.54	1.29	0.07*
P_7 x P_9	50.50	1.06**	-1.41	6.70	1.40	0.52**
P_7 x P_{10}	43.79	1.33*	3.74*	6.42	0.72	0.20**
P_8 x P_9	43.78	0.63*	-0.54	6.88	1.67	0.02
P_8 x P_{10}	49.50	1.13*	2.24	7.15	0.62	0.11**
P_9 x P_{10}	49.96	0.89**+	-1.55	6.88	1.51**++	-0.02

*,** b_i and S^2d_i significant at 5% and 1% level, respectively
+,++ b_i is significantly deviating from unity at 5% and 1% level, respectively

responsive i.e. b_i greater than unity (Table 2), indicating their suitability for favourable environments for higher grain yield plant^{-1}. Similar results have also been reported by Panwar and Dhaka (1998), Shadakshari *et al*. (2001), Swamy and Kumar (2003) and Vidhu Francis *et al*. (2005).

With respect to component traits as well as grain quality characters, parent P_5 (IET 13549) was average performer for harvest index, hulling percentage and kernel length. Likewise, P_6 (Pusa Bsamati-1) was average performer for spikelet sterility and milling percentage, indicating their suitability for any unpredictable environment for these characters, whereas P_8 (IET 13846) was above average responsive for panicle length and biological yield plant^{-1}. Hence, suitable for poor environments. Among the crosses, Taroari Basmati x IET 16320 had below average response for milling percentage, whereas IET 13549 x IET 13846 for biological yield plant^{-1}. Similarly, Pusa Basmati-1 x IET 13846 had below average response for days to 50% flowering, spikelet sterility, biological yield plant^{-1} and harvest index, indicating 7s suitability for favourable environments for these characters.

Hence, it may be concluded that parents IET 13549, Pusa Basmati-1 and IET 13846 and crosses Taroari Basmati x IET 16320, IET 13549 x IET 13846 and Pusa Basmati-1 x IET 13846 can be considered as most suitable and will provide stable performance under different environments with respect to these characters.

REFERENCES

Singh Ajmer, Chabra BS, Sabbarwal PS and Singh A 1997. Stability analysis for yield and its components in rice (*Oryza sativa* L.). Indian J Agric Res 31 (3) : 149-155

Breese EL 1969. The measurement and significance of genotype-environment interaction in grasses. Heredity 24 : 27-44

Eberhart SA and Russell WA 1966. Stability parameters for comparing varieties. Crop Sci 6 : 36-40

Kandhola SS and Panwar DVS 1999. Stability for grain yield and its components in rice. Ann Biol 15 (1) : 29-33

Mishra D and Dash SK 1997. Genetic diversity and stability in aromatic rice (*Oryza sativa* L.). Indian J Agric Sci 67 (1) : 27-29

Panwar A and Dhaka RPS 1998. Phenotypic stability for grain yield in rice. Oryza 35 (3) : 269-271

Rai M, Kerhi SA, Pandey S, Nafgri PS and Vashistha AK 1989. Stability analysis for some quality components of seed and oil in linseed. Indian J Genet 49 : 291-295

Senapati BK and Sarkar G 2004. Adaptability of Aman paddy under Sundarban areas of West Bengal. Indian J Genet 64 (2) : 139-140

Shadakshari YG, Chandrappa HM, Kulkarni RS and Shashidhar HE 2001. Genotype x environment interaction in lowland rice genotypes of hill zone of Karnataka. Indian J Genet 61 (4) : 350-352

Sreekumar SG, Nair VG and Asan RB 1993. Genotype x environment interaction and stability of pre-released cultures and varieties of rice. J Trop Agric 31 : 1-4

Swamy MN and Kumar BMD 2003. Stability analysis for grain yield and its components in rice. Karnataka J Agric Sci 16 (2) : 223-227

Vidhu Francis P, Kanakamany MT, Radhakrishnan VV and Jaikumaran U 2005. Genotype x environment interaction in rice (*Oryza sativa* L.). Oryza 42 (3) : 174-178