Ann. Agric. Res. New Series Vol. 27 (1) : 21-26 (2006)

STABILITY ASSESSMENT IN LATE DURATION RICE HYBRIDS

D. S. Sawant, R.L. Kunkerkar, V. N. Shetye and M. M. Shirdhankar

Agricultural Research Station, Shirgaon - 415 629, Maharashtra

Abstract

Analysis of variance carried out for eight quantitative traits on twenty-five genotypes (twenty-one hybrids and four check varieties) revealed significant genotypic differences at all the five locations for al the traits. Genotypes x location interactions were found to be significant for all the characters except 1000-grain weight. The variance due to genotype x location (linear) was significant only for days to 50% flowering. Non-linear component was found to be significant for all the characters. Among the 25 genotypes studied, only six rice hybrids had given significantly superior yield than populations mean. Out of these, two late rice hybrids viz., IR 58025 A/Karjat 14-7 and IR 68885 A/IR 5 had high potential and showed unit regression coefficient with non-significant non-linear component for grain yield/ha as well as for most of the yield contributing characters and hence suitable for all the environments in Konkan region of the Maharahtra State. While four late rice hybrids viz., IR 58025 A/IR 5, IR 58025 A/Ratnagiri 3, PMS 2 A/Ratnagiri 3 and IR 58025 A/Swarna had high yielding ability and showed significant regression coefficient greater than unity with non-significant no-linear component for grain yield/ha as well for most of the yield contributing characters. Therefore, these hybrids may be suitable in favorable environments only.

Key words : Hybrid rice, stability performance, environment, interaction.

Yield stability is one of the most desirable properties of genotype to be released for wide cultivation. Rice breeders, therefore, have always aimed to identify high yielding and stable genotypes and enormous work has been done on this aspect in rice. But meager information is available on stability of rice hybrids. As experienced in China, F_1 hybrid have increased rice varietal yield by about 20% (Yuan *et al*., 1985), the prospects of this technology are also being explored in India to increase varietal yields per unit area per unit time. Results so far obtained indicated that varietal yield per unit area per unit time can be increased significantly by the use of F1 hybrids (Varmani, 1986). Young and Virmani (1990a) also observed varying magnitude of heterosis over environments and stressed the need to evaluate hybrids across environment to identify stable hybrid with high yield that shows least interaction with environment. The present study is an attempt to identify high yielding and stable late duration hybrid over different location in the Konkan region of Maharashtra State.

Materials and Methods

Twenty one late rice hybrids with four locally well adapted check varieties of late duration were grown in randomized block design with three replications over five different locations in Konkan region of the Maharashtra State viz., Ratnagiri, Dapoli, Phondaghat, Karjat and Palghar during *Kharif* 1998. The trial was transplanted with a spacing of 20 cm between the rows and 15 cm between the plant in row with single seedling per hill. Gross plot and net plot size for each genotype was 5.10 x 1.20 sq.m. and 4.50 x 0.80 sq.m., respectively. All the recommended agronomic practices and plant protection measures were followed. The observations were recorded on ten randomly selected competitive plants except for days to 50% flowering, panicles per square meter and grain yield/ha, in each replication (Table 1). Panicles per square meters are based on 20-hill sample per net plot. Twenty hills with 20 x 15 cm spacing occupied on area of 0.60 sq.m. Hence for recording panicles per square meter, the panicles from 20 hills were multiplied by 1.67, as the sample area was 0.60 sq.m. The net plot size was 4.50 x 0.80 sq.m. For conversion of grain yield/plot into grain yield/ha, the yield of net plot was multiplied by 2777.778 as the sample area was 3.60 sq.m. and recorded the grain yield/ha in quintals. The data were analyzed for stability parameters based on model of Eberhert and Russel (1966).

RESULTS AND DISCUSSION

The mean squares due to genotypes and environments (E) were highly significant for all the characters under study which suggested significant differences among the genotypes and environments (Table 1). Highly significant genotypes x environment interactions were observed for all the characters implying differential behavior of hybrids under all environmental conditions ($p<0.01$). Similar reports were earlier made by Lohithaswa *et al.* (1999) in the rice hybrids. Significant variation due to environment (linear) was observed for all the characters except test weight revealing considerable additive environmental variance for these characters. The linear component of genotypes x environment interaction was non-significant ($p<0.05$) for all the characters except days to 50% flowering ($p<0.05$) suggesting that the genotypes did not differ for their linear response to environments. The mean squares for pooled deviation of the genotypes is entirely unpredictable in nature. These results are in conformity with the earlier findings of Lohithaswa *et al.* (1999).

According to Eberhart and Russel (1966), a stable genotype is one which shows (i) A high mean yield (ii) A regression coefficient (b=1) equal to unity and (iii) A mean square deviation from regression S^2di near to zero. According the present study, mean performance, $S^{-2}di$ of each cross combination was considered for stability and b_i was used for testing the genotypic response to environments. The regression coefficient is equal to unity ($b_i = 1$) means the genotype does not change according to changes in the environments indicating average linear response

Table 1 . Pooled analysis of variance for eight charaters in hybrid rice

Sources of variation	d.f.	Plant height (cm)	Productive tiller/plant	Days to 50% flowering	Panicles/m^2	Fertile spikelests/panicle	Spikelet fertility %	1000 grain (g)	Grain yield/ha (q)
Genotypes	24	325.32**	39.46**	26.98**	16868.71**	2592.02**	43.15**	30.80**	338.31**
Environments	4	188.00**	31.65**	22.53**	16443.25**	8039.19**	59.42**	0.34**	141.13**
Genotypes x Environments	96	19.16**	3.06**	2.64**	1415.05**	259.29**	15.00**	0.26**	24.17**
Environments (E) + (G x E)	100	25.19*	4.20	3.44**	2016.21**	570.49**	16.78	0.25	39.77*
Environment linear	1	752.01**	126.59**	90.15**	65774.88**	32156.68**	237.81**	0.38	1656.51**
G x L (linear)	24	20.17	2.18	4.80**	1192.39	295.07	13.21	0.30	19.98
Pooled deviation	75	18.07**	3.22**	1.84**	1429.69**	237.47**	14.98**	0.24**	24.54**
Pooled error	240	1.03	0.94	1.72	200.91	116.83	3.71	0.03	13.84

of hybrids to different environments; if it is greater than unity (b_i>1), the genotype is said to be sensitive to environmental changes indicating below average stability and suitability of favorable environments. If regression coefficient is less than unity (b_i < 1), it indicates that the genotype is above average stable and it is adapted specifically to widely differing environmental conditions. Taking mean performance and b_i of the hybrids into consideration their nature of adaptation was determined, if their $S^{-2}di$ was found non-significant.

All the three stability *viz.*, mean, b_i and $S^2 d_1$ seemed to be equally important. If at all and importance is to be given to a particular parameter, then the potential of a genotype to express greater mean over environments may be more important as the other two stability parameters, that is, the regression coefficient and the deviation mean square may not be of any practical utility if the hybrid is potentially weak. Accordingly in the present study, the rice hybrid which had given significantly superior yield than population mean (Mean + C D at 5% level), were considered for discussing the results. The details of the stability parameters *viz.,* mean, regression coefficient (b_i) and the deviation mean square ($S^{-2}d$), of growth, yield and yield contributing characters of selected six rice hybrids along with check are presented in Table 2.

The late rice hybrid IR 6885 A /IR 5 had high yielding ability and significant linear and non-significant non-linear component for grain yield / ha, productive tillers / plant and spikelet fertility percentage. This rice hybrid was closer to one (b = 1), which indicated that this hybrid was adaptive to all the environments in the Konkan region. This hybrid had given significantly (b_i< 1) higher values for productive tillers/ plant, panicles /m^2 and test weight than the population mean (Table 2). This hybrid also produced 14.17 quintals (30.90 %) yield advantage over best locally adapted highest late duration check IR 5.

The significant regression coefficient (b_i) and non-significant mean square deviation ($S^{-2}di$) indicated that the performance of genotype could be over predicted over the environments with adequate precision. The late duration and long slender rice hybrid IR 58025 A / KJT 14-7 produced 14.77 quintals (30.92 %) yield advantage over best locally adapted highest yielding late duration hybrid IR 5. The hybrid IR 58025 A / KJT 14-7 was found to be stable hybrid because regression coefficient wad close to unity (0.96^+) for grain yield / ha with least non-significant $S^{-2}d$ and associated with significantly higher yield than population mean. Similarly the adaptations in grain yield / ha of this rice hybrid was mainly due to adaptiveness of yield contributing characters like productive tillers / plant (0.99^{++}), fertile spikelets / panicle (1.06^{++}), spikelet fertility percentages (1.12^{++}), days to 50% flowering (1.13^+) and free from G x E interaction for panicles / m^2 (Table 2). This hybrid would sustain environmental fluctuations, hence IR 58025 A / KJT 14-7 proved one of the best fine grain, late duration stable rice hybrid for all the environmental situations in the Konkan region.

The late rice hybrid IR 58025 A/IR 5 had highest plant height, productive tillers / plant, panicles /m^2 , spikelet fertility percentage and test weight among the late maturing rice hybrids while showed the yield advantage of 20.28 quintals (44.25%) to that of the locally adapted highest yielding late duration check IR 5. This hybrid had significantly superior yield to that of the population mean but had a high regression coefficient significantly greater than one (b_i >1) with non-significant $S^{-2}d$ value. Therefore, this hybrid may be suitable for favourable environments only. The responsiveness for yield/h in this hybrid was found to be associated with productive tillers/plant (Table 2).

The three late rice hybrids viz., IR 58025 A / Ratnagiri 3, PMS 2 A/ Ratnagiri 3 and IR 58025 A /Swarna had high yield potential with non-significant deviations from linear regression, but more responsive to environmental change (b_i>1). Hence, these late duration hybrids were influenced by fluctuating environmental conditions and therefor, these hybrids may be suitable for favourable environments only. These three rice hybrids produced extra yield of 18.89 quintals (41.22%), 16.39 quintals (35.76%) and 15.28 quintals (33.34), respectively, over best locally

Table 2. Stability performance of growth and yield associated characters in selected rice hybrids

Hybrids	Plant height (cm)			Productive tillers/plant			Days to 50% flowering			Panicles/m^2		
	M	b_i	$S^{-2}d$	M	b_i	$S^{-2}d$	M	B_i	$S^{-2}d$	M	b_i	$S^{-2}d$
IR 58025 A / IR 5	118.20^{+}	1.78	22.73^{++}	14.60^{+}	1.84^{++**}	-0.90	106.60	1.10^{+}	0.53	358.00^{+}	0.91^{+}	-131.72
IR 58025 A Ratnagiri 3	109.60	1.07^{++}	1.19	14.60^{+}	1.84^{++**}	-0.90	107.40	-0.86	-0.90	350.60^{+}	0.90^{++}	-144.44
PMS 2 A / Ratnagiri 3	107.20	0.36	10.56^{++}	13.40^{++}	1.69^{++*}	-0.73	108.87	0.82^{+}	-0.51	339.80^{+}	0.91	-124.29^{++}
IR 58025 A/ Swarn	104.40	1.60^{++}	6.96^{++}	13.60^{+}	1.87^{++*}	1.52	107.20	-0.004	-0.80	333.80^{+}	0.92	1098.7^{++}
IR 58025 A / KJT 14-7	109.20	0.75	2.99^{++}	12.60	0.99^{++}	-0.89	107.00	1.13^{+}	0.73	327.00	0.46	-76.21
IR 6885 A / IR 5	108.80	2.72^{++}	39.57^{++}	13.00^{+}	1.14^{+}	0.18	106.00	0.20	0.21	332.00^{+}	0.51	243.29
CH. IR 5	114.4^{0+}	0.94	13.20^{++}	7.40	0.59	-0.46	114.40	1.71	6.49^{++}	240.20	1.50^{+}	902.12^{++}
Pooed average	107.80			10.25			108.10			275.41		
C. D. 5%	6.04			2.55			1.93			53.00		

Hybrids	Fertiles spikelets/panicle			Spikelet fertility %			Test weight (g)			Grain yield in q/ha		
	M	b_i	$S^{-2}d$	M	b_i	$S^{-2}d$	M	B_i	$S^{-2}d$	M	b_i	$S^{-2}d$
IR 58025 A / IR 5	182.60^{+}	0.63++	-71.34	87.72+	-1.02+	29.29++	25.91+	0.15	0.20++	66.11+	1.46++*	-11.53
IR 58025 A Ratnagiri 3	187.20^{+}	0.99++	21.84	83.80	0.74	5.83	24.47	4.29+	0.02	64.72+	1.37++**	-13.49
PMS 2 A / Ratnagiri 3	175.40	0.70^{+}	-99.34	84.75	1.57++	-2.06	25.16	4.31	0.29+	61.11++	1.44++	21.36
IR 58025 A/ Swarn	188.60^{+}	1.34++	151.46	38.07	-0.17	14.41++	20.91	7.34	0.29++	61.11+	1.44++	21.36
IR 58025 A / KJT 14-7	184.60^{+}	1.06++	-34.60	83.21	1.12++	-1.04	21.51	8.49	0.37++	60.00+	0.96+	-13.09
IR 6885 A / IR 5	175.00	1.58^{++}	246.27+	84.86	1.15++	0.29	25.77+	-1.80	0.04+	59.99+	0.98+	-1.33
CH. IR 5	119.80	0.57^{+}	-92.31	83.32	-0.01	5.91	27.34+	-2.60	0.16++	45.83	1.46++	-4.88
Pooed average	154.61			82.46			24.65			52.50		
C. D. 5%	21.91			4.80			0.69			7.04		

+,++ significant at 5% and 1% levels, respectively*,** Significantly diviating from unity at 5% and 1% level, respectively.

adapted highest yielding late duration check IR 5 and given value of productive tillers/plant, panicles /m^2 and fertile spikelets/panicle than the population mean. It is important to point out that responsiveness for gain yield were associated with productive tillers/plant and test without for IR 58025 A / Ratnagiri 3, productive tillers/plant, test, weight, fertile spikelets/panicle and plant height for IR 85025 A/ Swarna (Table 2).

It is to be pointed out that hitherto most of the hybrid rice breeders in India derived the heterosis in hybrid rice through WA source whereas few of them (Pandey *et al.*, 1990; Young and Virmani, 1990b; Wilfred Manual and Rangaswamy, 1994; Lavanya *et al.*, 1997; Hedge and Vidyachandra, 1998; wilfred Manual and Rangaswamy, 1994; Lavanya *et al.*, 1997; Hedge and Vidyachandra, 1998; Chaudhary and Virmani, 1998; Lohithaswa *et al.*, 1999; and Vijaykumar *et al.*, 2001;) have reported as stable over various locations,. In the present investigations, six rice hybrids of late duration group showed surpassing yields in the range of 23.13% to 46.14% over their highest yielding local checks. Of the six hybrids, it is to emphasize that beside five rice hybrids of WA source, one derived hybrid was of different source i.e. Mutant source showing stability. The hybrid of these sources are the first and foremost contributor in the rice farming in the Konkan region of Maharashtra State.

According to stability parameters viz., regression coefficient (b_i) and deviation from regression coefficient ($S^{-2}di$) estimated for each character indicated that none of the hybrids and standard checks were stable for all the characters under investigation. But six late duration hybrids had given significantly higher yield than population mean (mean + C D 5 %) and also significantly higher yield than similar duration check. These hybrids were also found to be stable for yield and important yield contributing characters. Young and Virmani (1990a) reported that none of the hybrids appeared to be stable for all the environments. Only five hybrids had above average yield and above average response (b=1.67 to 2.41) suited to specific environment. Pandey *et al.* (1990) identified one stable rice hybrid for spikelet fertility over different environments and one under unfavorable situation. Wilfred Manual and Rangaswamy (1994) studied 16 hybrid combinations in four environmental conditions for six characters and based on mean performance and stability parameters (b_i and $S^{-2}d_i$) identified two high yielding rice hybrids as the most stable and consistent hybrids for grain yield in all environments and three rice hybrids for highly favourable environments. Lavanya *et al.* (1997) evaluated 30 rice hybrids in five locations and identified only one hybrid, which ranked third in grain yield was stable over environment. Chaudhary and Virmani (1998) identified five superior and widely adapted hybrids in IRHON during 1994, which produced up to three tonnes / ha more gain yield than best locally adapted check variety. Hegde and Vidyachandra (1998) reported that no rice hybrid or check variety showed stability over the environments studied for yield. But one medium duration and one early duration hybrid performed superior for yield to that of high yielding check at all location except one. Lohithaswa et al. (1999) reported that among 15 hybrids, 11 hybrids showed stability for yield of which three hybrids had average stability (b_i=1). Vijaykumar et al (2001) reported the rice hybrid IR 58025 A /Swarna was less influenced by the interaction effect and identifies as having general adaptability at all locations and two hybrids were identified as specifically adapted to favourable by using AMMI model.

An array of the hybrids have been produced under this investigation with a view to have most suitable late duration hybrids, agronomically and environmentally for particular location in the region, it warrants for the careful testing of these hybrids which showed their performance at particular location in this investigation. Thus the multi-seasonal trials at a specific location are needed to select the better hybrid is most suitable and required for such location.

References

Chaudhary, R. C., Virmani, S. S. 1998. International testing of rice hybrids for yield and adaptability by INGER : Prospects and Problems. *Int. Rice Res. Notes.*, **23** (1) : 4.

Eberhart, S. A. and Russell, W. A. 1966. Stability parameters for comparing varieties. *Crop Sci.,* **6** : 36-40.

Hegde, S. and Vidyachandra, B. 1998. Stabillity analysis of rice hybrids. *Mysore J. agric. Sci.,* **32** : 38-43.

Lavanya, C., Vijakumar, R. and Sitadevi, B. 1997. Evaluation of rice hybrids in varying environments. *Int. Rice Res. Notes.,* **22** (2) : 15-16.

Lohithaswa, H. C., Bhushana, H. O., Basavarajaiah, D., Prasanna, H. C. and Kulkarni, R. S. 1999. Stabilty analysis of rice (*Oryza sativa* L.). hybrids. *Karnataka J. Agric. Sci.,* **12** : 48-54.

Pandey, K. Rathi, S. N., Patnaik, R. N., Jachuck, R. N. and Jachuck, P. J. 1990. Fertility restoration in cytoplasic male strile lines in rice . *Oryza*, **27** : 232-238.

Vijakumar, C. H. M., IIlyas-Ahmed, M.,Virktamath, B. C., Balakrishnan, R. and Remesha, M. S. 2001. Genotype x Environment interaction effects on yield of rice hybrids in India. *Indian J. Genet.*, **61** : 101-106.

Virmani, S. S. 1986. Prospects of hybrid rice in developing countries. **In** : Rice Progress assessment and orientation in 1980,s. Int. *Rice Comm. Newsl.* **34** (2) : 143-152.

Wilfred Manuel, M. and Rangaswamy, M. 1994. Stability performance in hybrid rice. *Oryza,* **31** : 16-21.

Young, J. B. and Virmani, S. S. 1990a. Heterosis in rice over encironments. *Euphyica,* **51** : 87-93.

Yong, J. B. and Virmani, S. S. 1990b. Stability analysis for agronomic traits in rice hybrids and their parents. *Oryza,* **27** : 109-121.

Yuan, L. P., Virmani, S. S. and Khush, G. S. 1985. Wei You 64-an early duration hybrid for China Int. *Rice Res. Newsl.*, **10** (5) : 11-12.