Stability Analysis for Grain Yield and its Component Traits in Rice (*Oryza sativa* L.)

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Abstract

Genotype x environment interaction was studied for grain yield and their component characters in eighteen parents and their 80 hybrids of rice under three environments during summer 2008. The environment + (genotype x environment) was significant for all the characters indicating distinct nature of environments and genotype x environment interactions in phenotypic expression. The genotype x environment (linear) interaction component showed significance for all the characters studied except 100 grain weight and number of grains per panicle. This indicated significant differences among the genotypes for linear response to environments (b_i) behavior of the genotypes could be predicted over environments more precisely and G X E interaction was outcome of the linear function of environmental components. Based on stability parameters and over all mean, five hybrids *viz.,* APMS 6 A X IR 62037 R, APMS 6 A X RR 347 R, IR 80559 A X MDU 5 R, IR 72081 A X TP 1021 R, IR 75596 A X ASD 06-8 R and IR 80154 A X TP 1021 R were stable in performance for grain yield. The parents IR 62037 R, RR 347 R, TP 1021 R and ASD 06-8 R can be used as a male parent for developing stable hybrids over the environments.

Rice, *Oryza sativa* (2n = 24) is the second most important cereal crop and staple food for more than one third of the world's population. Varietal adaptability to environmental fluctuations is important for the stabilization of crop production over both the regions and years. An information on genotype x environment interaction leads to successful evaluation of stable genotype, which could be used for general cultivation. Yield is a complex quantitative character and is greatly influenced by environmental fluctuations; hence, the selection for superior genotypes based on yield *per se* at a single location in a year may not be very effective. Thus, evaluation of genotypes for stability of performance under varying environmental conditions for yield has become an essential part of any breeding programme. An understanding of the causes of genotype x environment interaction can help in identifying traits and environments for better cultivar evaluation. For developing stable varieties, some stability parameters for which Finlay and Wilkinson (1963), Eberhart and Russell (1966), Perkins and Jinks (1968) and Freeman and Perkins (1971) have given some models and have been used in the search for an understanding of the causes of G x E interaction. Development of rice hybrids with high yield and desirable grain quality for different environments is one of the exciting research leads to successful evaluation of stable genotype, which could be used for general cultivation. Therefore, the present investigation was carried out, identifying stable genotypes with high yield using Eberhart and Russell model.

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Materials and Methods

The experimental material for the present investigation consisted of one hundred genotypes which included 18 parents *viz.,* IR 80559 A, APMS 6 A, IR 72081 A, IR 75601 A, IR 75596 A, IR 80154 A, CRMS 32 A, IR 75608 A, IR 62037 R, IR 72865 R, IR 68427 R, MDU 5 R, ACK 99017 R, TP 1021 R, RR 363 R, RR 347 R, RR 286 R, ASD 06-8 R and their eighty hybrids along with two checks. Crosses were effected between eight female and ten male parents in Line x Tester fashion and a total of 80 cross combinations were obtained and they were evaluated in randomized block design with two replications at Coimbatore (E1), Bhavanisagar (E2) and Aliyar Nagar (E3) during summer 2008. The hybrids along with their parents were sown in raised beds and 25 days old seedlings were transplanted in main field under puddled condition. For each genotype, single seedling per hill was planted at 20 x 20 cm spacing in two rows of 2.0 m length. Recommended fertilizer doses and cultural practices were adopted. Observations were recorded for eight quantitative characters *viz.,* days to 50 per cent flowering, plant height, number of productive tillers per plant, panicle length, number of secondary branches per panicle, number of grains per panicle, 100-grain weight and single plant yield. Statistical constants of mean for all the characters were estimated by Eberhart and Russell (1966) model.

Results and Discussion

Mean squares due to environment (linear) was found significant for most of the characters, indicating differences between environments and their influence on genotypes for expression of these characters (Table 1). This is in accordance with previous reports on rice by Sawant *et al.* (2005) and Panwar *et al.* (2008). The environment + (genotype x environment) was significant for all the characters indicating distinct nature of environments and genotype x environment interactions in phenotypic expression. The genotype x environment (linear) interaction component showed significance for all the characters studied except 100 grain weight and number of grains per panicle. This indicated significant differences among the genotypes for linear response to environments ($b_{i)}$ behavior of the genotypes could be predicted over environments more precisely and G X E interaction was outcome of the linear function of environmental components. Hence, prediction of performance of genotypes based on stability parameters would be feasible and reliable. Pande *et al.* (2006), Gouri Shankar *et al.* (2008) and Parry *et al.* (2008) also noticed significant linear component of G X E and non linear components of G x E interaction for most of the characters studied.

Eberhart and Russell (1966) defined a stable genotype as the one which showed high mean yield, regression co-efficient (b_i) around unity and deviation from regression near to zero. Accordingly, the mean and deviation from regression of each genotype were considered for stability and linear regression was used for testing the varietal response.

i. Genotypes with high mean, $b_i = 1$ with non significant δ^2_{di} are suitable for general adaptation, *i.e.*, suitable over all environmental conditions and they are considered as stable genotypes.

ii. Genotypes with high mean, $b_i > 1$ with non significant δ^2_{di} are considered as below average in stability. Such genotypes tend to respond favourably to better environments but give poor yield in unfavourable environments. Hence, they are suitable for favourable environments.

iii. Genotypes with low mean, $b_i < 1$ with non significant δ^2_{di} do not respond favourably to improved environmental conditions and hence, it could be regarded as specifically adapted to poor environments.

iv. Genotypes with any b_i value with significant δ^2_{di} are unstable

Table 1: ANOVA for stability (Eberhart and Russell model) for different quantitative characters

Source	df	Mean sum of square							
		DFF	PH	NPT	PL	NSB	100 GW	NG	SPY
Genotype	99	135.21**	109.94**	71.88**	18.94**	1.75*	0.07**	1530.73**	186.58**
Environment + (G x E)	200	18.37	42.26**	3.33	57.69**	1.14	0.04**	250.42**	15.81*
Environment (linear)	2	406.77**	2318.51**	155.95**	115.38**	3.15*	0.01	98.36	20.30
Genotype x Envt. (linear)	198	14.45**	27.17	3.29**	5.25	1.37**	0.03	110.39	13.47
Pooled deviation (non linear)	100	8.02**	34.43**	1.85**	8.27**	0.90**	0.05**	390.57**	18.07**
Pooled Error	297	2.44	3.49	1.34	1.44	0.38	0.01	53.75	3.25

* Significant at 5 % level   ** Significant at 1 % level

Eight parents and 14 hybrids for days to 50 % flowering; six parents *viz.*, IR 75596 A, CRMS 32 A, IR 62037 A, RR 363 A, RR 347 A and ASD 06-8 A and 21 hybrids for plant height; nine parents namely IR 72081 A, IR 75596 A, IR 80154 A, IR 62037 R, IR 68427 R, MDU 5 R, TP 1021 R, RR 347 R, RR 286 R and 19 hybrids for number of productive tillers per plant; four parents such as IR 80559 A (1.01), IR 72865 R (1.12), MDU 5 R (0.73), TP 1021 R (0.93) and twelve hybrids for panicle length; two hybrids *viz.*, APMS 6 A X RR 286 R and IR 75596 A X ASD 06-8 R had values near to unit regression. Hence, these genotypes are suitable for over all environmental conditions and they are considered as stable genotypes.

Grain yield is the most important trait in the development of rice hybrids. Identification of a hybrid with high grain yield, stability and average response is of immense value. A perusal of stability parameters for grain yield per plant indicated that out of eighteen parents, the parents APMS 6 A and IR 72081 A registered higher grain yield and showed significant bi value. Among the eighty hybrids, two hybrids *viz.*, APMS 2 A X RR 286 R and IR 80154 A X IR 62037 R registered significant bi value and showed non significant deviation from regression near zero. Therefore, these genotypes were stable for grain yield in all the environments. Similar findings were reported by Gouri Shankar *et al.* (2008).

Out of the eighty hybrids, eight hybrids *viz.*, IR 80559 A X ACK 99017 R, IR 80559 A X RR 286 R, APMS 6 A X ACK 99017 R, APMS 6 A X ASD 06-8 R, IR 72081 A X IR 68427 R, IR 72081 A X MDU 5 R, IR 72081 A X RR 347 R and IR 75601 A X RR 347 R had the regression value significantly more than one ($b_i > 1$) and showed non significant deviation from regression (Table 2). Hence, these genotypes were found to be suitable for favourable environments and there is yield reduction in the unfavourable environments. The hybrids viz., IR 80559 A X IR 68427 R, CRMS 32 A X TP 1021 R and IR 75608 A X ASD 06-8 R had the regression value below one ($b_i < 1$) and were found to be suited for unfavourable / poor environments. Similar results were observed by Bhakta and Das (2008) and Panwar *et al.* (2008).

It is concluded from the present study that the five hybrids *viz.*, APMS 6 A X IR 62037 R, APMS 6 A X RR 347 R, IR 80559 A X MDU 5 R, IR 72081 A X TP 1021 R, IR 75596 A X ASD 06-8 R and IR 80154 A X TP 1021 R were stable in performance for grain yield. The parents IR 62037 R, RR 347 R, TP 1021 R and ASD 06-8 R can be used as a male parent for developing stable hybrids for all the environments.

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