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GENOTYPE X ENVIRONMENT INTERACTION FOR GRAIN YIELD IN LOWLAND RICE CULTIVARS

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ABSTRACT

Genotype × environment interaction was studied for grain yield in 24 genotypes of lowland rice under five different environments in eastern India. Significant genotype (G) and environment (E) interaction was observed. Both linear and non- linear components of G × E interaction were significant, linear component being the predominant. On the basis of stability parameters two genotypes, RAU 79-2-14 and RAU 617-59-14-1 were found to be most stable with high grain yield over different environments. The selection from Raipur (IET6286/Bd.83)-29 was identified as suitable genotype for favourable environments.

Key words: Lowland rice, G × E interaction, stability, grain yield

Rice is grown under different agro-climatic conditions in India, particularly in eastern part of the country. Of the 42.3 m.ha of the rice area in India, 17.5 m.ha is under rainfed lowlands of which 14.0 m.ha is located in eastern India. Rice yields were very low (< 1.0 t/ha) under this lowland situation due to erratic rainfall and flash floods. The study of genotype-environment interaction provides useful information to identify stable genotypes over a range of environments. The present investigation was therefore, under taken to study G × E interaction and to identify both high yielding and stable genotypes over different lowland situations in eastern India.

MATERIALS AND METHODS

Twenty four genotypes of lowland rice including 20 fixed cultures from different states of eastern India along with four standard checks (Sabita, Rajshree, Mahsuri and Manoharsali) were grown in a randomized block design with two replications at five different locations viz., Cuttack (Orissa), Masodha (U.P.), Patna (Bihar), Raipur (M.P.) and Titabar (Assam) under ICAR-IRRI collaborative shuttle breeding programme on population improvement for rainfed lowlands of eastern India [1]. The crop was direct seeded at Masodha and Raipur, while it was transplanted at Cuttack, Patna and Titabar during the wet season, 1996. The plot size was 10 sq.m and spacing between rows and plants was 20 and 15 cm respectively. During the crop growth period the recommended package of practices were followed at all the locations. Grain yield was recorded on plot basis and converted to kg/ha. The Bartletts test has been employed to test the homogeneity of error variances of different environments. The data were analysed statistically for stability parameters based on [2]. The significance of stability parameter (bi) and its deviation from unity were tested by t test.

RESULTS AND DISCUSSION

The analysis of variance for individual as well as pooled environments showed that mean differences between genotypes were highly significant for grain yield indicating thereby the presence of genetic variability among genotypes included in the present study. Pooled analysis (Table 1) also indicated significant variation among the environments and their influence on grain yield. Significant mean squares due to genotype × environment (G × E) interaction revealed that the genotypes interacted considerably with the environmental conditions that existed at different locations.

Table 1. Pooled analysis of variance for grain yield in lowland rice cultivars

Source	df	Mean squares
Genotypes (G)	23	3379130.4^{**++}
Environments (E)	4	9692500.0^{**++}
G × E	92	1986304.3^{**++}
Environment (Linear)	1	19382736.0^{**++}
G × E (Linear)	23	1410416.9^{**+}
Pooled deviation	72	818521.6^{**}
Pooled error	120	144379.2

**Significant at 1% level against pooled error
$^{++}$ and $^{+}$ significant at 1% and 5% levels respectively against pooled deviation

Highly significant mean squares due to environment (linear) indicated that environments differed considerably from location to location. The environmental index ranged from –543.8 at Cuttack to 462.8 at Masodha. Titabar had a negative index of –379.1 while Patna and Raipur had index values of 385.3 and 74.7 respectively. The positive and negative values of environmental index indicated the favorable (Masodha, Patna and Raipur) and unfavorable (Cuttack and Titabar) locations respectively for grain yield during the wet season 1996.

Both linear and non-linear components of G × E interaction were significant. However, the linear component was significant against the pooled deviation, which indicated that a large portion of G × E interaction was accounted for by the linear regression although non-linear component (pooled deviation) was also found significant. The predominance of linear component noticed would help in predicting the performance of the genotypes across environments.

The grain yield of rice fluctuates considerably with the change in environmental conditions. Hence, a variety possessing reasonable stability for grain yield is desirable. Different measures of stability have been used by various workers. Finlay and Wilkinson [3] considered linear regression as a measure of stability, whereas Eberhart and Russell [2] emphasized that both linear (bi) and non-linear (S^2di) components of genotype- environment interaction be considered while judging the phenotypic stability of a genotype. From the subsequent studies on this aspect it is suggested [4, 5] that linear regression (bi) could simply be regarded as measure of response of a particular genotype. whereas, deviation from regression (S^2di) should be considered as measure of stability. Accordingly, the mean ($\bar{X}$) and deviation from regression (S^2di) of each genotype were considered for stability and linear regression (bi) was used for testing the varietal response. Genotypes with lowest or non-significant mean square deviation being the most stable and vice-versa. The three parameters $\bar{X}$, bi and s^2di together gave an idea of adaptability of genotypes across the locations.

The mean ($\bar{x}$), regression co-efficient (bi) and deviation from regression (s^2di) for grain yield are presented in Table 2. In the present study the magnitude of regression co-efficient and deviation from regression varied from genotype to genotype. Out of the 24 genotypes tested only six viz., CR 758-8, OR 1352-RGA-DR- 20-2, PSR 1326-29-3-3-1, RAU 79-2-14, RAU 617-59-14-1 and a selection from Raipur (IET 6286/Bd.83)-29 were found stable for grain yield over environments as indicated by their non-significant deviation from regression (S^2di). Among these stable genotypes, three viz., RAU 79-2-14, RAU 617-59-14-1 and CR 758-8 are average in response to changes in environmental conditions as indicated by their regression co-efficient(bi) near unity suggesting average stability and wider adaptability of these genotypes. Whereas, two genotypes PSR 1326-29-3-3-1 and OR 1352-RGA-DR-20-2 were identified as suitable genotypes for unfavourable environments as indicated by their low bi values (< 1.0). On the otherhand, significantly high regression co-efficient value (> 1.0) for the selection from Raipur (IET6286/Bd.83)-29 indicated its suitability for favorable environments.

Table 2. Estimates of stability parameters for grain yield in lowland rice cultivars

Genotype	$\overline{X}$*(kg/ha)*	*bi*	S^2di
CR 662-2211	3703	1.62 ± 0.81	391958*
CR 780-1937	3911	1.45 ± 0.70	251677*
CR 758-8	3051	2.12* ± 0.59	140448
OR 1334-8	4224	0.44 ± 0.83	417626*
OR 1335-7	4130	0.53 ± 1.43	1519328**
OR 1352-RGA-DR-20-2	3172	0.17 ± 0.57	120541
OR 1356-RGA-DR-7	3223	−2.02 ± 1.02	692123**
CN 718-8-21-10	3775	0.26 ± 0.97	621792**
CN 1035-59	3488	1.73 ± 0.89	502732**
CN 1015-11	1997	−2.75 ± 0.94	574343**
PSR 1314-108-106	2778	1.54 ± 0.95	588013**
PSR 1326-29-3-3-1	3421	1.33 ± 0.57	115372
RAU 79-2-14	4288	1.34** ± 0.20	−115542
RAU 83-82-4	3682	1.09 ± 0.87	465040**
RAU 617-59-14-1	3913	2.58* ± 0.63	182792
NDR 95003	4234	1.09 ± 1.96	2969282**
NDR 96001	3339	2.94 ± 1.11	898132**
R 243-32-32	3377	2.13 ± 1.79	2433364**
(IET 6286/Bd.83)-29	3734	2.82*+ ± 0.50	58835
BG 380-2	2767	1.02 ± 1.36	1346622**
Manoharsali	2425	0.08 ± 0.75	315934*
Sabita	3236	1.08 ± 0.91	527384**
Rajshree	3044	1.14 ± 1.06	756842**
Mahsuri	3155	0.24 ± 0.82	400777*
Mean	3419	1.00	
S.E	452	1.01	

* and ** significant at 5% and 1% levels, respectively

+bi : significantly different from unity at 5% level

Among the stable genotypes RAU 79-2-14 showed highest grain yield (4288 kg/ha) followed by RAU 617-59-14-1 (3913 kg/ha), (IET 6286/Bd.83)-29 (3734 kg/ha), PSR 1326-29-3-3-1 (3421 kg/ha), OR 1352-RGA-DR-20-2 (3172 kg/ha) and CR 758-8 (3051 kg/ha). On the other hand, the genotypes viz., NDR 95003 (4234 kg/ha), OR 1334-8 (4224 kg/ha) and OR 1335-7 (4130 kg/ha), which recorded high mean grain yield were found to be unstable in their performance over environments as indicated by their significant deviation from regression (s^2di). The rest of the genotypes are low yielder as well as unstable.

A simultaneous consideration of all the three parameters ($\bar{x}$, bi and s^2di) showed that RAU 79-2-14 and RAU 617-59-14-1 were the most adaptable with least mean square deviation (s^2di), regression co-efficient (b) near to unity and high grain yield. The selection from Raipur (IET 6286/Bd.83)-29, which was stable and high yielder showed regression coefficient significantly higher than unity suggesting that this genotype would performed well under favorable environments.

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