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Short Communication

Genotype × environment interaction effects on yield of rainfed lowland rice (*Oryza sativa* L.) varieties

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In Uttar Pradesh about 42% rice (*Oryza sativa* L.) area is under rainfed lowland especially in eastern part of the state. Rice yields in general are very low (< 1.0 metric t/ha) under this ecosystem due to various macro and micro environmental factors. The study of genotype × environment interaction provides useful information to identify stable genotypes across environments [1-2]. The present study was therefore, undertaken to study G × E interaction and to identify both high yielding and stable rice varieties across different rainfed lowland situations in eastern Uttar Pradesh.

Eighteen varieties of rainfed lowland rice were grown in a randomized complete block design with three replications at four locations *viz.* Masodha Unit III Faizabad, Masodha Unit I Faizabad, Tissuhi-Mirzapur and Gograghat-Baharaich. Generally the stagnation of water depth in the field varies from 20-50 cm at these locations. 25-30 days old seedlings were planted at all locations, during *Kharif* 1999. Grain yield was recorded on plot basis and converted to metric t/ha. was used for statistical analysis.

Using the AMMI (Additive main effects and multiplicative interaction) analysis and biplot facility therefrom, the rainfed lowland rice yield trial data were analysed to determine the nature and magnitude of G × E interaction effects on grain yield in diverse production environments [3]. The data were analysed by using BSTAT and MS-EXCEL.

The AMMI analysis of variance (Table 1) clearly indicates that genotypes and environments are significant and accounted for 24.37 and 54.47 percent of the total treatment sum of squares. The proportion of variance due to GEI, which is considered as residual in ANOVA, was the third (21.16%). Thus ANOVA accounted for only 78.84% of the treatment combinations SS attributable to genotypes and environment effects.

The GEI was further partitioned in to three PCA axes (IPCA) with contributionof 55.49, 37.99 and 6.52 percent to the total GEI variance. Among them only 1st PCA was significant and jointly accounted for 100% of interaction component with 100% of the df for GEI. The 2nd and 3rd components were not significant.

Table 1. Analysis of variance based on AMMI model

Source	d.f.	Sum of squares	Mean square
Genotype (G)	17	23.117	1.360*
Environment (E)	3	51.668	17.233*
GE interaction	51	20.074	0.394
AMMI component 1	19	11.138	0.586*
AMMI component 2	17	7.626	0.449
AMMI component 3	15	1.309	0.873

* = Significant at 5% level.

Table 2 presents the mean yield data for 18 varieties evaluated in this study across the four locations. The grain yield ranged from 1.61 to 5.48 metric t/ha. The location mean of Masodha-III was higher (4.23) and of Masodha-I more or less equal to overall mean (3.17). The first principal component scores were negative (–0.910 and –0.381 respectively) at these two locations. The locations mean of Tissuhi and Gograghat (2.86 and 2,59 respectively) was less than the overall mean but the first principal component scores were positive (0.531 and 0.759 respectively).

AMMI estimates coincided with the observed ranking of genotypes in all the locations, which shows that GEI was closely disclosed by AMMI model. Thus it is concluded that AMMI model is more effective in analysing multilocational yield data. The effectiveness of AMMI procedure has been clearly demonstrated in rice [4].

The first principal component score was dominated by high interaction effect on yield of NDR 4008 and Swarna. The varieties differed among themselves not only for mean yields, but also for their interaction effects. The varieties, which have less GE interaction, are more widely adaptable. The GEI effect differes from

Table 2. Mean grain yield (t/ha) of 18 rainfed lowland rice variaties grown in 4 locations and the first PCA scores for the GE interaction effect as derived from AMMI analysis

Varieties	Genotype mean	First PCA
NDR 4001	3.15	–0.022
NDR 4008	2.27	0.714
NDR 4010	2.92	0.382
NDR 4031	3.29	0.438
NDR 4062	3.12	–0.094
NDR 4073	3.48	0.107
NDR 4082	2.89	0.114
NDR 4084	3.40	0.151
NDR 4105	4.01	–0.266
NDR 4106	2.89	–0.505
NDR 4111	2.84	0.277
NDR 4112	3.27	0.066
NDR 4179	3.21	0.044
NDR 4182	2.97	–0.099
NDR 4207	2.86	–0.246
Jal Lahari	4.14	–0.341
Mahsuri	3.40	0.012
Swarna	2.98	–0.534
Overall mean	3.17*	-

variety to variety. Three varieties *viz.*, Mahsuri, NDR 4179 and NDR 4112 were having general adaptability at all locations. The variety NDR 4031 was specificaly adapted to favourable locations. Masodha-III, Madodha-I and Tissuhi are most favourable for the variety NDR 4105 and Jallahri.

Location Masodha-III having negative PCA score with higher yield potential had good conditions for genotypes. It was not only the highest yielding but also interacting with almost zero score on PCA score and thus, suitable for growing specific rainfed lowland rice genotypes. Location Gograghat had higher interaction effect but its yield potential was below average. Location Masodha-I and Tissuhi had moderate interaction effect but their yield potential was only average and below average respectively. The location Tissuhi is highly interacting and therefore, this is most suitable for specifically adapted genotypes. The location Gograghat differed for both main effects and interactions. It indicates that all genotypes evaluated are not suitable for this location.

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