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GENOTYPE-ENVIRONMENT INTERACTION AND STABILITY PARAMETERS FOR PADDY YIELD

Muhammad Akram [a]*, *Syed Sultan Ali* [b] *and F M Abassi* [a]

[a]*National Agricultural Research Centre, Islamabad, Pakistan*

[b]*Rice Research Institute, Kala Shah Kaku, Pakistan*

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Six rice genotypes were evaluated for paddy yield across five locations during 1993. The differences among rice genotypes and locations were highly significant. Genotype x location interaction was also highly significant. Stability analysis showed that rice genotypes, Super Basmati (4048) and Basmati 385, were stable for paddy yield because of mean yield greater than grand mean yield, regression coefficient near unity and small deviations from regression (S^2d). S^2d was significant for all genotypes except for 4048 and Basmati 385. The rice line 4439 with maximum mean paddy yield (4926 kg ha^{-1}) across locations, was found to be suitable in Nuclear Institute for Agriculture and Biology, Faisalabad (NIAB) and Gujranwala environments.

Key words: Stability analysis, Rice, Yield, Location.

Introduction

The ultimate goal of plant breeders is to develop high yielding uniform lines, consistent in their performance at more than one environment. Before releasing them as variety, these lines are tested in National Uniform Rice Yield Trials (NURYT) under diverse environmental conditions i.e. across different years at different locations or with a combination of both to determine the relative performance of newly developed lines over years/locations and their interaction effects. The presence of genotype x environment interaction can impede progress from selection by concealing genotypic effects. Genotype x environment interaction results in changing the genotypic response for different agronomic traits. Therefore, unique genotype cannot be recommended for all environments. It is more feasible for a plant breeder to develop lines, well adapted to more than one environment and can be successfully grown over a wide range of environments. Stability analysis, proposed by Finally and Wilkinson (1963) and further refined by Eberhart and Russell (1966), is a good technique for measuring the adaptability of different crop varieties to variable environments. Several other researchers have attempted to measure the relationship between genotypes and environment. Scott (1967) showed that yield stability is genetically controlled and thus suitable for selection. Lewise (1954) defined the phenotypic stability as the ability of an individual to produce a certain narrow range of phenotypes in different environments. Yates and Cochran (1933) proposed that the regression of yield on the environmental index as measured by the mean yield of all cultivars in a particular environment, would provide a parameter of the stability of hybrids. Aslam *et al* (1988), Ali *et al* (1992 a & b) observed in maize and rice that genotypes ranking from yield and other traits change with the change in environments. Anon (1995) and Akhtar and Sneller (1996) also observed significant genotypes x cropping system interaction in soybean and rice for all growth parameters and yield.

In the present investigations, Eberhart and Russell (1966) method was used to identify stable genotypes.

Materials and Methods

The experimental materials, comprised four fine rice varieties i.e. Super Basmati 4048, Basmati 385, Basmati Pak and Basmati 370 and two advance lines 4439 & 4029-3. The experiment was laid out in randomized Complete Block Design, replicated thrice at a wide range of environments i.e. NIAB, Faisalabad, Gujranwala, Dokri, Jamra and Tando Jam during the year 1993. Plot size used, for each genotype was 2 x $5m^2$/replication/location with 20x20 cm spacing between plants and rows. Identical agronomic and plant protection measures were adopted for all genotypes. NPK was applied @ 120-60-0 kg ha^{-1}. At maturity, crop was harvested and yield recorden in kg ha^{-1} adjusting moisture at 14% level.

The data recorded was analyzed according to Steel and Torrie (1980) to observe genetic variation among rice genotypes at different locations. As the data showed significant genotype x location interaction, the stability analysis

*Author for correspondence

decribed by Eberhart and Russell (1966) was used to observe the stability in performance of six rice genotypes at different locations.

The analysis permitted the partitioning of location and genotype x location interaction sources of variation into location (linear), genotype x location (linear) interaction (sum of squares due to regression bi) and (unexplainable deviation square S^2d). Therefore an ideal genotype as characterized by Eberhart and Russel (1966) would be the one, having a high mean yield, regression coefficient (bi) near unity and deviation from regression (S^2d) close to zero.

Results and Discussion

Mean squares for paddy yield of six rice genotypes across five locations indicated high significant differences among genotypes and locations. Significant effect of replications within locations was observed. The interaction between genotypes and locations was also found to be highly significant, indicating that the genotypes and locations were not independent of one another (Table 1).

Mean squares from the analysis of variance for stability are shown in Table 2. The sum of squares due to location and genotype x location was partitioned into location (linear), genotype x location (linear) and deviation from the regression model. This table depicted that the differences among rice genotype means were significant. The F-test for genotype x location (linear) was nonsignificant. F-test for pooled deviations was found to be significant for the combined analysis. (Aslam *et al* 1988; Ali *et al* 1992 a&b; Anon 1995; Akhtar and Sneller 1996). Same results were observed by other scientists for G x E interaction in soyabean, rice and maize respectively. Mean paddy yield for six rice genotypes across five locations ranged from 3602.73 kg ha^{-1} to 4926.07 kg ha^{-1} with an average of 4181.0 kg ha^{-1} (Table 3).

The regression of genotypes average paddy yield on the location index resulted in regression coefficients or bi-values which ranged from 0.3656 to 1.6428. The regression coefficient (bi-value) was observed to be nonsignificant for all rice genotypes. The deviation from regression mean squares (S^2d), a true measure of genotypic stability, was significant for all genotypes except for 4048 and Basmati 385, meaning thereby that non-significant values for S^2d can be considered as zero. Genotype 4439 with maximum mean paddy yield (4926.07 kg ha^{-1}) and bi near unity showed general adaptability but poor phenotypic stability due to significant S^2d. It showed sensitivity to environmental changes. However, this genotype showed more than 6000 kg ha^{-1} in NIAB and Gujranwala environments. Coefficients of determination (r^2) were calculated between mean paddy yield and individual genotypes and location index in the experiments. These coefficients showed the variation due to each genotype and ranged from 0.326 to 0.969. However, only Basmati 385 had r^2 value of > 0.950. The rice genotypes Basmati 4048 and 385 showed mean above the grand mean, bi-values near unity (nonsignificant) deviations from regression coefficients (S^2d).

Eberhart and Russell (1966) characterized ideal variety, the one having a high mean yield, a regression coefficient near unity and deviation from regression close to zero. Based on these parameters, the rice genotypes Super Basmati (4048)

Table 1
Analysis of variance for yield (kg ha^{-1}) of six rice genotypes across five locations

Source of variation	D.F.	Mean squares
Genotypes	5	5455719.08**
Locations	4	3819381.03**
Reps. In locations	10	174860.8*
Genotype x location	20	1423072.13**
Error	50	80440.32

*,**, Significant at 0.05 and 0.01 levels, respectively.

Table 2
Stability analysis of variance for paddy yield (kg ha^{-1}) of six rice genotypes across five locations

Source of variation	D.F.	Mean squares
Genotypes	5	1818560* MS1
Locations (genotype x location)	24	1031865
Locations (linear)	1	1.52776 E-07
Genotype x location (linear)	5	674366 MS2
Pooled deviation	18	339737.9** MS3
Pooled error	60	32059.02

*,**, Significant at 0.05 and 0.01 levels, respectively.

Table 3
Mean paddy yield (kg ha^{-1}) and estimates of stability parameters for six rice genotypes across five locations

Genotypes	Mean yield (X)	bi	S^2d	r^2
Super Basmati 4048	4410.87	0.8075	25.03	0.947
4439	4926.07	1.6150	134.595*	0.772
4029-3	3602.73	0.3656	220.989**	0.942
Basmati 385	4786.00	1.6428	75.686	0.969
Basmati Pak	3760.07	0.8010	176.131*	0.725
Basmati 370	3603.93	0.7682	397.413**	0.326

S.E, 550.54; *,**, Significant at 0.05 and 0.01 levels, respectively; bi, regression coefficient; S^2d, Deviation from regression coefficient; r^2, Coefficient of determination.

and Basmati 385 have average stability for paddy yield. These lines can be recommended for the future breeding programme aiming at the development of cultivars with better yield potentials over a wide range of environments.

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