*Pak J Sci Ind Res 2000 **43** (3) 188-190*

Evaluation of Different Rice Genotypes for Stability in Yield Performance

Abdul Qayyum*, M.Usman Mufti and Sajjad Akhtar Rabbani

National Agricultural Research Centre, PO-NIH, Park Road, Islamabad, Pakistan.

(Received 24 March 1997; accepted 14 February 2000)

The stability analysis of variance for six rice genotypes, tested across environments, indicated that the genetic differences among rice genotypes were significant at 5% level of probability. Genotypes x location interaction was non-significant. The regression coefficients (b_i) and small deviations from regression (δ^2)of the genotypes Pak-4554 and Basmati-385 were found to be non-significant. The latter was significant for all genotypes except Pak-4554 and Basmati-385. Basmati-385 performed almost better at all locations. Therefore, the ideal rice genotype was Basmati-385 which showed average stable results.

Key words: *Oryza sativa,* Genotypes, Yield, Environmental interaction, Genetic stability.

Introduction

Rice *(Oryza sativa* L) is one of the most important crop in Pakistan, being the second largest contributor in the export earnings after cotton (Anon 1996).

Pakistan has varied agro-climatic regions including high mountainous valleys and irrigated plains. So, the environmental factors such as, rainfall, temperature, fertility status and soil characteristics etc play important role in the varietal performance. However, it is much more difficult to find out genotype-environment interaction in terms of population or individual buffering (Allard and Bradshah 1964). The release of a genotype with consistent performance over a range of environments may lead to stability in production. Therefore, a measure of the relative stability of the varieties under a wide range of environmental conditions becomes necessary in chalking out an efficient varietal evaluation programme.

Stability in the performance of a crop is its ability to show the minimum of interaction with the environment. The stability in performance, being a genetic characteristic, requires the preliminary identification of the stable genotypes. Eberhart and Russell's Model (1966) is one of the techniques used to rank the varieties for stability. The model uses simple linear regression to describe various types of varietal adaptabilities to wide range of environments as a quantitative measure of phenotypic stability.

Finlay and Wilkinson (1963) adopted regression analysis approach in the study and concluded that cultivars with a regression coefficient (b_i) around 1.0 would be stable across environments. Eberhart and Russell (1966) proposed regression coefficient (b_i) as the parameter of response and deviations from regression (δ^2) as the parameter of stability.

Stability analysis, proposed by Finlay 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. Aslam *et al* (1988) and Ali *et al* (1992 a&b) observed in maize and rice crops that the genotypes ranking for yield and other traits change with the change in environment.

Eberhart and Russell's approach (1966) was used to obtain the objective of identifying the stable genotypes which could be recommended for growing under diverse environmental conditions.

Materials and Methods

The experimental material comprised of six rice varieties or lines, *viz* Pak-81, Pak-369, Pak-370, Pak-4553, Pak-4554 and Basmati-385. The experiment was laid out in randomized complete block design (RCBD) with three replications in a wide range of environments *i.e.* Farooqabad, Sialkot, Gujranwala, Kala Shah Kaku and Faisalabad during the year 1995. Plot size for each genotype was 3 x 5 m^2, while row to row and plant to plant spacing was 20 cm. NPK was applied @120-60-0 kg ha^{-1}. Identical agronomic and plant protection measures were adopted for all genotypes/locations. Paddy was harvested at 14% moisture level and yield was recorded in kg ha^{-1}.

The data were analyzed according to Steel and Torrie (1980), to observe the genetic variation amongs rice genotypes at different locations. Stability analysis by Eberhart and Russell (1966) was used to observe the stability performance of different rice genotypes at different locations.

*Author for correspondence

Table 1
Paddy yield (kg ha^{-1}) of six rice varieties across five locations

Varieties	Farooqabad		Sialkot		Gujranwala		Kala Shah Kaku		Faisalabad	
	Mean yield	Rank	Mean yield	Rank	Mean yield	Rank	Mean yield	Rank	Mean yield	Rank
Pak-81	3167b	5	3989abc	3	4233a	1	5320a	1	3992bc	3
Pak-369	3133b	6	3822c	5	4000ab	4	2503c	6	4125b	2
Pak-370	3633b	2	3844bc	4	3767bc	5	2747c	5	3079d	6
Pak-4553	3233b	3	3267d	6	3733c	6	4637b	3	3855c	5
Pak-4554	3200b	4	4167ab	2	4017ab	3	4413b	4	3902c	4
Pak-385	4233a	1	4283a	1	4200a	2	4820b	2	4355a	1
LSD (5 %)	461.4		312.7		253.0		474.3		206.1	

* Values followed by the same letter are not significantly differently from each other by DMRT.

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

Sources of variation	D.F.	S S	MS	
Total	29	10.982		
Genotypes	5	3.417	0.6830*	MS_1
Environment + G x Env.	24	7.565	-	
Environment(linear)	1	1.481	-	
G x Env (linear)	5	1.932	0.3386ns	MS_2
Pooled deviation	18	4.152	0.230	MS_3
Pak-81	3	0.574	-	-
Pak-369	3	1.866	-	-
Pak-370	3	0.779	-	-
Pak-4553	3	0.674	-	-
PaK-4554	3	0.068	-	-
Bas-385	3	0.191	-	-
Pooled error	60	0.776	-	-

* Significant at 5% level of probability; ns, non-significant

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

Variety	Mean (kg ha^{-1})	S^2	CV (%)	bi	Deviation from Reg (δ^2)
PAK-81	4140	0.598	8.35	2.72	0.574
PAK-369	3517	0.468	8.70	0.15	1.866
PAK-370	3414	0.229	6.26	0.74	0.779
PAK-4553	3745	0.325	6.80	1.59	0.674
PAK-4554	3940	0.208	5.17	1.76	0.068
BAS-385	4378	0.064	2.59	0.52	0.191
G.Mean:		3856		6.00	

Results and Discussion

The mean yield performance of six rice varieties at five locations revealed large fluctuations within an environment as well as between environments (Table 1). At Farooqabad, variety Basmati-385 produced the highest yield (4233 kg ha^{-1}) followed by Pak-370 (3633 kg ha^{-1}). At Sialkot, the variety Basmati-385 showed better performance followed by Pak-4554 and Pak-81. However, mean yield differences between these varieties were statistically non-significant. At Gujranwala Pak-81 gave the highest yield of 4233 kg ha^{-1}. However, it did not differ significantly from Basmati-385, Pak-4554 and Pak-369 varieties. Pak-81 outyielded (5320 kg ha^{-1}) all the varieties at Kala Shah Kaku followed by Basmati-385 and Pak-4553. However, their mean yield differences were significant. At Faisalabad, the highest yield (4355 kg ha^{-1}) was given by Basmati-385 whereas Pak-370 proved to be the lowest yielder. Here, Basmati-385 significantly differed from other varieties.

Mean squares from the analysis of variance for stability and the sum of squares due to Environment plus Genotype x Environment (GxE) were partitioned into Environment (linear), Genotype x Environment(linear) and deviations (Table 2). The table showed that the differences among rice genotype means were significant. The F-test for Genotype x Environment (GxE) interaction was found non-significant, indicating that there was no genetic difference among rice genotypes.

The regression coefficient and deviation from regression for mean rice yield of six varieties across five environments are shown in Table 3. The regression co-efficient (b_i) ranged from -0.74 to 2.72. One of the top three producing varieties, Pak-81 had the highest regression co-efficient. Varieties Pak-4553 and Pak-4554 had greater regression coefficient (b_i) from 1.0, Pak-369 and Basmati-385 had b<l; the last variety. Pak-370 had -0.74.

The deviation from regression (δ^2) showed distinct differences among the varieties. For the evaluation of response to

different environmental conditions, a stable variety is defined as one which has a regression co-efficient around 1.0 with minimum deviation from regression. The deviation from regression (δ^2) ranged from 0.068 to 1.866. Minimum deviations from regression were recorded by rice varieties Pak-4554 and Basmati-385. However, the varieties Pak-4554 and Basmati-385 showed mean above the grand mean; b_i- values indicated that there was insignificant differences for the regression coefficients from unity. The δ^2 was significant for all the varieties except Pak-4554 and Basmati-385. Pak-4554 and Basmati-385 had deviation from regression (δ^2) near to zero. Eberhart and Russell (1966) characterized an ideal variety as having a high mean yield, a regression coefficient near unity (b_i) and deviation from regression (δ^2) close to zero. Based on these characterization, the rice genotypes Pak-4554 and Basmati-385 have average stability for rice yield. Francis and Kannenberg (1978) generalized that the smaller the numerical values of (s^2) and C.V(%), the more stable is the genotype. Based on these assumptions, variety Basmati-385 has the smaller values of (s^2) (0.064) and C.V (2.59) as compared to other varieties. It is, however, important to test these rice cultivars across environments for a few more years, before their release for general cultivation. Since stability in yield is genetically controlled (Eberhart and Russell 1966; Perkins and Jinks 1968), varieties Pak-4554 and Basmati-385 may be used as parents for developing stable cultivars.

References

Ali S S, Jafri S J H, Mahmood S, Butt M A 1992a Stability analysis for irrigated rice yield IRAN **17** (5) 5-6.

Ali S S, Jafri S J H, Khan M G, Butt M A 1992b Stability parameters for seedling traits in rice *(Oryza sativa* L*)* JAPS **2** (3-4) 117-12l.

Allard R W, Bradshah A D 1964 Implications of genotype-environment interactions in applied plant breeding. *Crop Sci* **4** 503-507.

Anon 1996 Economic Survey of Pakistan 1995-96. Finance Division, Economic Adviser's Wing, Ministry of Finance. Government of Pakistan, Islamabad.

Aslam M, Javaid H I, Mailk H N, Rahman H 1988. Genotype x environment interaction and stability of performance among different varieties of maize in Pakistan. *Pak J Agri Res* **9** (l):52-55.

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

Finlay K W, Wilkinson G N 1963 The analysis of adaptation in plant breeding programme. *Aust J Agri Res* **14** 742-754.

Francis T R, L W Kannenberg 1978 Yield stability studies in short-season maize. I A descriptive method of grouping genotype. *Can J Plant Sci* **58** 1029-1034.

Perkins M J, Jinks J L 1968 Environmental and genotype-environmental components of variability. *Heredity* **28** (2) 333-356.

Steel R G D, Torrie J H 1980 *Principles and Procedures of Statistics, A Biometrical approach.* McGraw Hill Book Co, New York.