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Stability Analysis And Genotype X Environment Interaction For Grain Yield In Basmati Rice Genotypes

Jay Laxami, Bupesh Kumar and A.K. Razdan

Division of Plant Breeding and Genetics, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu

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Abstract

The present study was conducted to determine genotype x environment interaction and performance of 12 locally adapted as well as improved Basmati rice genotypes across four rice cultivating environments viz., E_1 (Normal transplanting), E_2 (Late transplanting), E_3 (System of rice intensification, SRI) and E_4 (Direct Seeded Rice, DSR) in Randomized Block Design in order to identify the stable rice genotypes. Yield stability was analyzed employing Eberhart and Russell's model which revealed highly significant differences among genotypes and environments. Mean squares due to environment + genotype x environment interactions (E+G x E) revealed that genotypes interacted considerably with environmental conditions. Further, partitioning of E+G x E effects indicated that E (linear), G x E (linear) components were highly significant for grain yield. Genotypes Pusa Basmati1509, Pusa Basmati 1121, Pusa Sugandh 2, Jammu Basmati 129 and Basmati 564 had higher mean than general mean coupled with regression coefficient close to unity $b_i = 1$ and $S^2 d_i = 0$ were found to be most stable and desirable genotypes for grain yield per plant across rice production environments under study.

Key words: Stability, rice cultivating environments, G X E, Basmati rice

Introduction

Rice (*Oryza sativa* L.) belonging to family *Poaceae* is one of the oldest domesticated crops which provides food for more than half of the world's population. It significantly contributes in rice economy in India and serves as a major staple for more than 70 per cent of the people dwelling in Asia. In India, during *Kharif* 2016 it was cultivated over an area 44.0 m ha with production and productivity of 108.8 m tones and 2.47 tones/ha respectively (Anonymous, 2016)

Jammu & Kashmir is predominantly rice cultivating state covering an area of 271.49 thousand hectare with production and productivity of 5567 thousand quintals and 21.51 quintals hectare^{-1}, respectively (Anonymous, 2014) thereby, playing an important role in the livelihood security of people of the state. Among various rice types *viz,.* coarse, fine, semi fine etc. Basmati rice having pleasant aroma, sweet

Corresponding author's e-mail : juhisingh1714@gmail.com
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taste and superfine long grains is the premium group cultivated in the Himalayan foothill regions of India and Pakistan. The demand of this group is increasing worldwide and it ensures higher returns to the farmers being priced three times more than non-basmati rice in the International as well as in Indian domestic markets. In Jammu region of J&K state Basmati rice commands a premium place being cultivated on an area of 62.25 thousand hectares with production of 129.04 metric tons (Anonymous, 2016) and has great export potential to augment the income of the farmers.

Now days, conventional method of rice cultivation viz., puddled transplanted rice is facing severe constraints because of water and labour scarcity coupled with climatic changes. Therefore, necessitating to search alternative methods with good potential to save water, reduce labour requirement, mitigate green-house gas emission and adapt to climatic risks. Genotype x environment interaction (GEI) exists when the responses of two genotypes to different levels of environmental stress are not consistent (Allard and Bradshaw, 1964). G x E interactions greatly affect the phenotype of a variety, so the stability analysis is required to characterize the performance of varieties in different environments, to help plant breeders in selecting varieties. Eberhart and Russell (1966) found that an ideal cultivar is one that has the highest yield over a broad range of environments. They defined a stable cultivar as that with regression coefficient (b_i) equals to one and with mean squares deviation from regression S^2d equal to zero. Therefore, in the present study an attempt was made to evaluate 12 locally adapted/improved rice genotypes so as to identify stable ones.

Material and Methods

Twelve locally adapted as well as improved Basmati cultivars viz., Basmati 370, Basmati 564, Saanwal Basmati, Ranbir Basmati, Jammu Basmati 129, Pusa Sugandh 2, Pusa Basmati 1121, Pusa 1401, Pusa Basmati 1509, PB 1, CSR 30 and Pusa 1460 were evaluated in a randomized complete block design with three replications at SKUAST, Chatha farm, Jammu during *kharif* 2016. These genotypes were grown in four environments E_1(Normal transplanting), E_2(Late transplanting), E_3(System of Rice Intensification) and E_4(Direct Seeded Rice) having a plot size 1.6 m^2. Observation were recorded on five randomly selected plants in each replication in each environment for grain yield/plant and stability analysis was carried out following Eberhart and Russell (1966) Model.

Results and Discussion

Plant breeders are interested in knowing buffering capacity of genotypes with respect to economic traits like yield so as to select genotypes exhibiting low genotype x environment interactions. Genotypes possessing good buffering capacity are considered as desirable and are recommended for cultivation across different production ecosystems.

Table 1. Joint regression analysis of variance for yield following Eberhart and Russell (1966)

Source of variation	df	MSS (Grain yield/plant)(g)
Environments	3	74.40**
Genotypes	11	7.47**
G X E	33	3.94**
E + (G X E)	36	7.98**
Environments(linear)	1	223.20**
G X E (linear)	11	3.43**
Pooled deviation	24	1.10
Pooled deviation	88	4.98

**** indicate p<0.01 level of significance * indicate p<0.001 level of significance**

Joint regression with respect to mean performance of a genotype on an environmental index (b_i) is the popular approach in which deviation from regression (S^2d_i) is used as a measure of stability. Joint regression analysis of variance for yield is presented in Table 1. Mean sum of squares due to genotype and environment were found to be significantly different for grain yield per plant. Similar reports on rice were earlier made by Blanche *et al*. (2009), Misra *et al*. (2010), Sreedhar *et al*. (2011), Mosavi *et al*. (2013), and Kulsum *et al*. (2013). Mean sum of squares due to E+(G x E) were found to be significant whereas mean sum of squares due to G x E (linear) and environment (linear) was significant for grain yield per plant. Menon *et al.* (1997) reported that the environmental linear component was significant for grain yield, while Madariya *et al.* (2001) reported both linear and nonlinear components of GEI for grain yield. These results confirm the findings of Shantha *et al.* (2007) and Samrat *et al*. (2010).

Table 2: Stability parameters of yield following joint regression analysis (Eberhart and Russell (1966)

S.No.	Genotypes		Grain yield/plant(g)	
		$\overline{X}$	b_i	S^2d_i
1.	Basmati 370	13.15	1.56	-3.97
2.	Basmati 564	13.71	0.70	-4.83
3.	Saanwal Basmati	12.41	0.69	-4.81
4.	Ranbir Basmati	13.15	0.80	-4.82
5.	Jammu Basmati 129	14.39	0.49	1.10
6.	Pusa Sugandh-2	14.87	1.10	-3.86
7.	Pusa Basmati 1121	16.89	0.85	-4.75
8.	Pusa 1401	13.40	1.38	-2.54
9.	Pusa Basmati 1509	13.82	0.80	-4.08
10.	Pusa Basmati 1	13.56	1.91	-4.22
11.	CSR 30	11.24	1.14	-4.26
12.	Pusa 1460	13.28	0.60	-4.87

General Mean= 13.66

Stability analysis helps in characterizing the performance of genotypes in different environments which enable plant breeders in selecting desirable genotypes while instability is the result of cultivars response in different environments usually indicates a high interaction between genetic and environmental factors. Following Eberhart and Russell model (1966), three parameters mean ($\overline{\text{X}}$), regression coefficient (b_i) and deviation from regression (S^2d_i) are indicative of stability of genotypes. Genotypes with high mean ($\overline{\text{X}}$) performance, a regression coefficient of unity (b_i=1), and minimum deviation from regression line(S^2d_i=0) exhibit better general adaptability across environments and are considered as a stable ones. Where βi > 1, the genotype is responsive to favorable environment. If βi < 1, the genotype performs well despite an unfavorable environment. Stability analysis for yield is presented in Table 2. Genotypes Pusa Basmati 1509, Pusa Basmati 1121, Pusa Sugandh 2, Jammu Basmati 129 and Basmati 564 had higher mean than general mean coupled with regression coefficient close to unity, $b_i = 1 \text{ and } S^2d_i = 0$ are most stable and desirable ones for grain yield per plant.

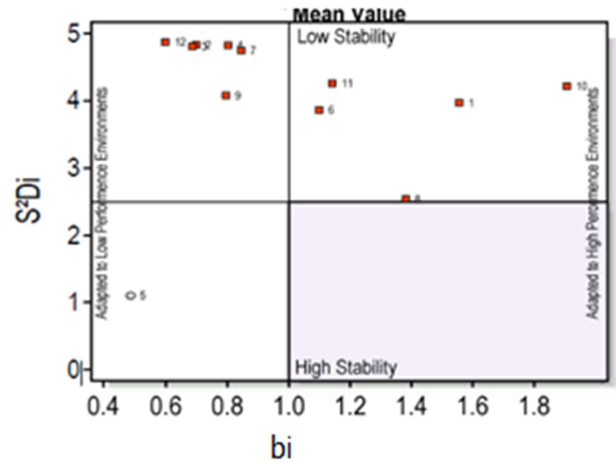

Fig 1. Yield stability of Basmati genotypes (Eberhart and Russell, 1966)

Genotypes Pusa Basmati 1509, Pusa Basmati 1121, Pusa Sugandh 2, Jammu Basmati 129 and Basmati 564 had higher mean than general mean coupled with regression coefficient close to unity $b_i = 1 \text{ and } S^2d_i = 0$ and are most stable and desirable ones for grain yield per plant. Genotype Jammu Basmati 129 has high stability and adapted to low performance environment and genotype Pusa Basmati 1 has low stability and is adapted to high performance environment, whereas, genotype Pusa 1460 has low stability and adapted to low performance environment (Fig.1). Similar conclusion was reported by Mosa *et al.* (2009); Abd El-Moula (2011) and Abdallah *et al.* (2011) which are in close conformity with present findings.

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