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Environmental Responses and Stability Analysis for Grain Yield of Some Rice Genotypes

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ABSTRACT

Five rice promising genotypes, Danesh, Jahesh, Milad, Partov, Jelodar, and seven rice genotypes parents, Sangtarom, Tarommahali, Dilamani, Noksiah, Sepidrod, R9, Fajr were investigated for grain yield stability of 2010-11 over tree locations in North of Iran. The results obtained showed highly significant yield differences among rice genotypes, environment and genotype by environment interaction. Some rice genotypes were adjudged stable when different yield stability parameters were considered. DANESH showed adaptation to favorable environments while PARTOV demonstrated insensitivity to environmental conditions, hence it was considered adapted to low-yielding environments. A combination of high grain yield potential, stability parameter of regression coefficient of unity and minimum deviation mean squares from regression identified JELODAR as a rice genotype that deserved to be promoted on-farm and for possible release as commercial varieties for the rice growing ecologies in North of Iran.

Keywords: Rice, Yield, Stability, Environmental Responses, Iran.

INTRODUCTION

The yield Stability of performance is one of the most desirable properties of a genotype to be released as a variety for cultivation. Stability is a complex product of genetic yield potential to stress conditions. Breeding genotypes that are adapted throughout a reasonable large geographical area and that show some degree of stability from year to year is a major problem facing plant breeders. As a result, several methods of measuring and describing genotypic response across environments have been developed a utilized. For this purpose, multilocational trials, over a number of years are conducted. Sometimes unilocational trials can also serve the purpose provided different environments are created by planting experimental materials at different dates of sowing, using various spacing, doses of fertilizers and irrigational levels, etc [1, 2]. One of the most frequently used stability measures is based on a regression model [3]. However, it was developed by Finlay [4] to describe the adaptation of individual varieties to changing environment and while Eberhart [5], used b-values as measures of environmental response and deviations from regression as measures of stability. Several of these statistics have been summarized and compared by Lin [6] who pointed out that stability statistics fall into four groups depending on whether they are based on the deviation from the average genotype effect or on the genotype by environment term and whether or not they incorporate a regression model on an environment index. A genotype may be considered stable if its environmental variance is small, if its response to environment is parallel to the mean response of all genotypes in the trial, or if the residual mean square from a regression model on the environmental index is small.

MATERIALS AND METHODS

In experiments were conducted during the 2010 and 2011 cropping seasons at three locations, Rasht, Chalous, Sari. Twelve rice genotypes (five rice promising genotypes, Danesh, Jahesh, Milad, Partov, Jelodar, and seven rice parents' genotypes, Sangtarom, Tarommahali, Dilamani, Noksiah, Sepidrod, R9, Fajr) were planted in a plot of 4m x 5m spaced at 0.6m intra plot and 0.8 m between blocks. The trial sites were slashed, burnt and manually prepared with hoe by leveling it. The grains were sown at one grains per hole spaced at 25cm x 25cm, this gives 20 rows of 5m long, with 20 stands each. Data on grain yield was collected at maturity by harvesting the central rows within 3m x 3m, threshed carefully, winnowed and the seeds weighed and recorded in kilograms. Grain yield per plot was then used to estimate yields in tones per hectare [7]. For developing stable genotypes, some stability parameters for which's: varietal mean [4], regression coefficient [5], deviation from regression [8], e covariance (W2) [9] and coefficient of variation (CV%) [10].

RESULTS AND DISCUSSION

The environmental means for grain yield are showed in Table 1. Mean yield ranged from 3.666 T ha^{-1} for environment 2 to 6.1206 T ha^{-1} for environment 4. Soil structure, texture, fertility and rainfall might have contributed towards this variation. Unpredictable environmental factors such as temperature and rainfall, even at a single location may contribute to genotype by environmental interaction over year. Adeyemo [11], and Malik [12] implicated these environmental factors in their studies. Testing genotypes over different location differing in unpredictable environmental variation is a suitable approach for selecting stable genotypes [5].

Table 1: The Experimental sites and mean grain yield (t/ha)

Year	Environment	Mean Yield (T/Ha)
2010	RASHT	5.959
2010	CHALOUS	3.666
2010	SARI	4.129
2011	RASHT	6.120
2011	CHALOUS	3.395
2011	SARI	4.177

The mean squares from analysis of variance for grain yield are showed in Table 2. The mean squares indicated highly significant differences for environments, genotypes and genotype x environmental interaction. Also, genotype x environmental interaction was highly significant showing that the relative performances of the genotypes were significantly affected by the varying environmental conditions.

Table 2: Analysis of variance for grain yield combined in three locations for 2010 and 2011 planting season.

Source of Variation	df	Mean Square	F-ratio	Probability>F
Model	35	1.303E7	23.708	<0.0001
Blocks (Envir)	2	1.229E8	223.566	<0.0001
Genotypes	11	1.111E7	20.221	<0.0001
E * G	22	4002630.367	7.282	<0.0001
Error	180	549645.682	-	-
Total	215			

The mean grain yields and stability parameters of the rice genotypes are showed in Table 3. The genotypic variance and genotypic coefficient of variation indicated that SANGTAROM was more stable since it has the least value for these parameters. However, with respect to equivalence and stability variance, JELODAR that had the least value of 1.238 and 0.58, respectively. Thus, these genotype the basis of these statistics. This implies therefore that there was low contribution to the genotypic x environment interaction.The linear regression coefficient and the deviation from the regression values for different rice genotypes revealed a wide variation in performance across environments. JELODAR were interesting since it was relatively stable in performance when adjudged by stability parameters. It had the highest mean yield of 5.877 t/ha, b value close to unity and a small d2. DANESH had a b value greater than one and had a high yield indicating that it will respond to a favorable environment. This implies that there is low contribution to the genotype by environment interaction; hence it is specifically adapted to a high yielding environment. PARTOV had a high mean yield and b value less than one, indicating insensitivity to the environment and it adaptation to low yielding environment. Generally, any high yielding and relatively stable genotype under different environment would have high mean, low e covalence with b close to one. Graphs of the regression of genotypes mean on environmental mean for these 5 genotypes are shown in Figure 1. JELODAR had a slope closer to unity, followed by DANESH, NOKSIAH had the least slope.

Table 3: Stability parameters for 12 genotypes at 6 environments in North of Iran.

Rice genotypes	Stability parameter						
	Mean yield (t/ha)	Variance (S2)	Coefficient of variation (CV%)	E Covalence (W2)	Stability variance (Q2)	Regression slope (b)	Deviation mean squares (S2d)
R9	4.323	1.033	23.5	2.317	1.23	1.74	0.127
Jahesh	4.497	0.685	18.4	1.759	0.89	1.57	1.9
Milad	3.348	0.465	20.36	2.814	1.52	1.19	0.982
Danesh	5.342	1.927	25.99	2.364	1.25	1.59	2.359
Fajr	5.131	1.799	26.14	2.455	1.4	1.48	0.917
Partov	4.588	0.509	15.55	2.165	1.13	0.81	0.241
Sepidrod	5.364	1.417	22.19	8.089	4.69	1.36	1.435
Tarommahali	4.391	1.242	25.38	3.033	1.66	1.77	1.762
Jelodar	5.877	1.322	19.56	1.238	0.58	1.05	0.273
Dilamani	4.099	1.537	30.24	1.3	0.81	0.95	1.23
Sangtarom	4.679	0.406	13.62	5.947	3.4	1.04	0.672
Noksiah	3.258	3.163	38.87	1.377	0.76	1.93	2.279

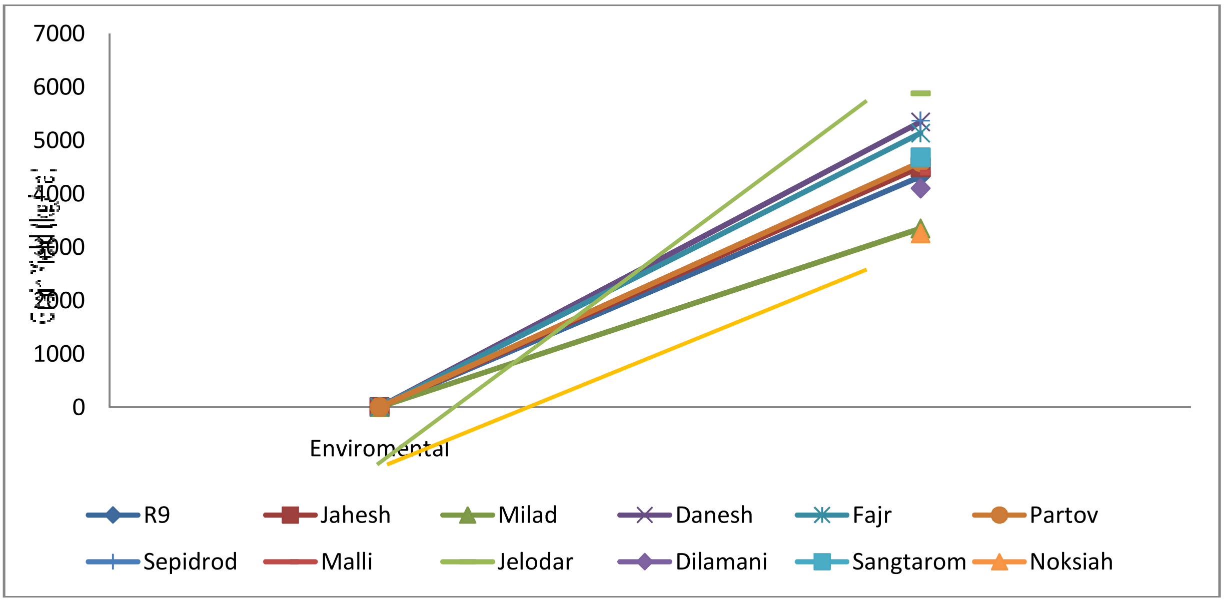

Figure 1. Linear relationship between mean yields of rice genotypes and environment

CONCLUSION

The stability of the twelve genotypes was evaluated. Based on genotypic variance and genotypic coefficient of variation indicated that SANGTAROM was more stable compared with genotypes since it has the least value for these parameters. While DANESH gave indication that it is adapted to favorable environment and PARTOV demonstrated insensitivity to environmental conditions, hence it is considered adapted to low yielding environment. A combination of high grain yield potential, regression coefficient of unity and minimum deviation from regression identified JELODAR as rice genotypes that deserved to be promoted on-farm and for subsequent release as commercial varieties for the rice growing ecologies in north of Iran.

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