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Genotype-Environment Interaction for Grain Yield in Mash (*Vigna mungo* L. Hepper)

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Abstract: The genotype-environment interaction for grain yield was studied in ten mash genotypes under six diverse environments. Significant differences among the genotypes and the environments indicated the presence of variability among the genotypes as well as the environments under study. Both predictable (linear) and unpredictable (non-linear) portions of variation were found to be significant indicating equal importance in determining the stability of grain yield. Genotype '9010' was the most adaptable showing highest grain yield, average response and non-significant deviation from regression.

Key words: Genotype-environment interaction, grain yield, stability, mash, *Vigna mungo*

Introduction

Crop yield stability is an important issue for farmers, breeders, geneticists, and production agronomists. When phenotypic ranking of a set of cultivars is not stable across an array of environments, then environment seemingly has played its role under this situation. The only choice left with breeder is to identify genotypes well adapted to diverse environments. A more stable genotype, as compared to others, should give relatively more stable yield across the environments. The genotype-environment interaction (GEI) can be utilized to help reduce breeding and testing costs. Environments can be grouped together as test sites for site specific recommendations of cultivars. Performance of a cultivar specifically adapted to a certain environment is usually enhanced through this concept.

There are several methods used to measure crop yield stability. Among these, more popular and widely used is the linear regression analysis as proposed by Eberhart and Russell (1966).

Mash is important kharif pulse crop of Pakistan. Its production and national average yield exhibits fluctuation mainly due to cultivation of low yielding and environment sensitive genotypes. Yield stability of a genotype in such a situation is true indicator of its inherent potential (Pandey *et al.*, 1981). Therefore, emphasis should be put on the identification of genotypes, which could perform better irrespective of changes in environment. Many workers have reported GEI in mash and other pulse crops (Malhotra *et al.*, 1971; Pandey *et al.*, 1981; Khan *et al.*, 1987; Khan *et al.*, 1988; Rao and Suryawanshi, 1988; Bakhsh *et al.*, 1995; Sharif *et al.*, 1998 and Qureshi, 2001.) still information in this regard on mash cultivars cultivated in Pakistan is scanty.

Thus, this study was undertaken on phenotypic stability of promising mash genotypes to find out ones with comparatively better and consistent grain yield irrespective of variations in growing conditions.

Materials and Methods

Ten genotypes of mash (98-cm-524, BRS-57, Mash-3, 9006, BRS-48, 9081, 98-cm-525, 9092, Mash-97 and 9010) were evaluated at six locations representing different climatic conditions (Table 1) during kharif, 2000. At each location, the trial was conducted in Randomized Complete Block Design. Each experimental plot consisted of six rows of four m length. Row to row and plant to plant distances were kept at 30 and 10 cm, respectively. Recommended cultural practices were applied to maintain a healthy crop stand. Stability parameters were worked out as suggested by Eberhart and Russel (1966).

Table 1: Research institutes/stations where 10 genotypes of mash were tested for stability parameters of grain yield

Research institutes/stations	Location in the country
Regional Agricultural Research Institute, Bahawalpur	Southern Punjab
Nuclear Institute for Agriculture, Tandojam	Southern Sindh
Arid Zone Research Institute, Bhakkar	Southern Punjab
Agricultural Research Station, Mingora, Swat	Northern NWFP
Barani Agricultural Research Institute, Chakwal	Northern Punjab
National Agricultural Research Center, Islamabad	Northern Punjab

Results and Discussion

Differences among genotypes and genotype-environment interactions were significant (Table 2). Both genotype-environment (linear) and pooled deviation were highly significant against pooled error mean square indicating involvement of linear as well as non-linear components of variation. The genotype x environment (linear) mean square was, however, non-significant when tested against pooled deviation mean square.

In this study linear regression (bi) was simply regarded as measure of response of a particular genotype, whereas, the deviation from the regression line (S^2di) was considered as measure of stability; genotypes with lowest or non-significant standard deviation being the most stable and vice versa. The mean performance, the regression (bi) and deviation from regression (S^2di) components of genotype-environment interactions for ten genotypes are presented in Table 3. It is evident that regressions of all the genotypes except one (98-cm-524) are not different from linearity while deviations are different from pooled error for six genotypes (BRS-57, 9006, BRS-48, 9081, 98-cm-525 and Mash-97).

Table 2: Pooled analysis of variance for grain yield in mash.

Source of variation	df	Mean square
Genotype	9	8094.00*
Environment	5	547655.88**
Genotype x Environment	45	13363.97**
Environment + (Genotype x Environment)	50	66793.16**
Environment (Linear)	1	2738280.00**
Genotype x Environment (Linear)	9	9722.06**
Pooled Deviation	40	12846.99**
Pooled Error	162	3646.04

*, ** indicates significance at 5 and 1% level of probability , respectively.

Table 3: Estimates of stability parameters for grain yield in mash.

Genotypes	Mean (Xi)	bi ± S.E (bi)	S^2di
98-CM-524	670.57	0.56* ±0.16	6903.58
BRS-57	724.60	1.28 ±0.28	21919.24**
Mash-3	669.03	1.03 ±0.12	3951.27
9006	651.56	0.94 ±0.19	10308.62**
BRS-48	661.61	1.12 ±0.24	15497.59**
9081	663.66	1.14 ±0.24	15279.05**
98-CM-525	689.15	1.04 ±0.26	18294.31**
9092	698.43	0.94 ±0.17	7646.15
Mash-97	701.19	0.96 ±0.28	21416.39**
9010	773.38	0.98 ±0.16	7253.66
Mean	690.32	1.00	

*, ** indicates significance at 5 and 1% level of probability , respectively.

Finlay and Wilkinson (1963) and Perkins and Jinks (1968) found that linear response was positively associated with mean performance. Eberhart and Russell (1966), Paroda and Hayes (1971), Westerman (1971), Gautam (1971) and Saxena (1975), however, emphasized that both linear (bi) and non-linear (S^2di) components of genotype-environment interaction should be considered in judging the phenotypic stability of a particular genotype and their responses were independent from each other. Jain and Pandya (1988) suggested that the desired genotype in any practical situation is one with high mean performance, desired linear response (bi) and low non-linear sensitivity coefficient (S^2di). If these aspects are controlled by different genetic systems, then a desirable genotype may be bred through standard breeding procedures. Further, Samuel *et al.* (1970) suggested that the linear regression could simply be regarded as a measure of response of a particular genotype which depends largely upon a number of environments, whereas the deviation from regression line was considered as a measure of stability, genotype with the lowest or non-significant standard deviation being the most stable and vice versa. The genotype-environment interaction was also studied in various crops by different researchers (Jindla *et al.*, 1985; Pethani and Kapoor, 1985; Satija and Gupta, 1985 and Sharif *et al.*, 1998).

Since regression coefficients of all the genotypes except one, are not significantly different from 1, therefore, the stability of these genotypes should be judged upon other two parameters (Xi & S^2di). The genotype '98-cm-524' had low and significantly different regression from linearity, which indicated its better adaptability under unfavorable environments. Its non-significant deviation from regression showed that it was less affected by environmental changes. However, this genotype cannot be recommended due to its low yield potential.

The genotype '9010' exhibited the highest average yield and lesser sensitivity to environmental changes. So, giving high yield, this genotype was relatively more stable in performance over the environments.

The genotypes 'Mash-97' and '9092' had above average yield having high and low deviation from regression, respectively. High deviation from regression of 'Mash-97' indicated that this genotype showed sensitivity to environmental variations and producing higher yields under favorable conditions. Whereas, '9092' revealed stable performance across the environments which is evident from its low deviation from regression. The genotype '98-cm-525' produced average yield with high deviation from regression indicating its sensitivity to environmental fluctuations. The genotype 'Mash-3' had below average yield with low deviation from regression indicating better stability but low genetic potential. The genotypes '9006', 'BRS-48' and '9081' had also below average yield and also their deviation from regression showed higher sensitivity to environmental changes. These genotypes revealed poor genetic potential under different environments under study.

Thus on the basis of this study it could be concluded that the genotype '9010' was the most adaptable and best suited under various environments tested.

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