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Phenotypic Stability for Grain Yield in Maize Genotypes under Varied Rainfed Environments

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Abstract: Six maize genotypes viz. EV-1089, EV-1098, EV-5089, EV-5098, EV-6089 and EV-6098 were tested for their yield performance under four different locations of Barani tract. A number of statistics such as genotype mean performance, genotypic variance, genotypic coefficient of variation, ecovalence and regression coefficients were estimated to evaluate the environments effect on the grain yield. Keeping in view the mean yield performance of the genotypes over locations and estimates of different statistics, genotype EV-5098 and EV-5089 may be considered relatively less sensitive to change in environments and can successfully be grown over varied soil and climatic conditions.

Key words: Maize, *Zea mays,* stability, G x E interaction

Introduction

Assessment of the stability and adaptability of a genotype to different environments is useful for recommending cultivars for known conditions of cultivations. Cultivars are often evaluated in different environments to identify the ones that are best yielding and more stable. The genotype x environment (G x E) interactions encountered in such multilocational trials can influence the evaluation of the true genetic potential of the cultivars and can hinder progress in breeding widely adapted crop varieties.

Maize is the major cash crop of Rawalpindi division. The yield of maize varieties varies widely due to variation in soil and climatic factors, which complicates the identification of a superior variety. The climatic conditions vary not only with the location in the same year but also from year to year at the same location in the Barani tract. Furthermore, the varieties not always respond alike under various climatic conditions.

Comstock and Moll (1963) pointed out that the phenotype reflects genetic as well as non-genetic influence on development and the effects of genotype and environment are not independent.

The phenotypic response to a change environment is not the same for all genotypes. Stability analysis is used to identify varieties with consistent yield performance across environments. Several methods have been used to evaluate stability of characters of different genotypes.

Eberhardt and Russell (1966) proposed that varieties having deviation from regression coefficient approaching zero are more stable. Mani and Singh (1999) studied the yield stability in twelve maize genotypes (hybrids and composites) over three diverse environments. The composite Navin followed by the double top cross hybrid EHF–1121 was found to be the most stable genotype with respect to yield. Parag *et al.* (2000) found six maize genotypes stable for grain yield and other yield components among 22 genotypes evaluated for stability over three environments.

Scapim *et al.* (2000) tested 20 maize cultivars at 8 locations for two years. It was observed that cultivar Dina –170 that had a greater general yield was characterized as cultivar adapted to favorable environments and was among the most productive in the different environment assessed. The cultivar G-96C showed medium adaptation to all environments (ideal cultivars) and had good stability. The present study was carried out to ascertain the adaptability and yield performance of six promising maize genotypes grown under four varied rain fed environments.

Materials and Methods

Six maize genotypes viz. EV-1089, EV-1098, EV-5089, EV-5098, EV-6089 and EV-6098 were evaluated for their yield performance over four locations during kharif-2000. The experiment was sown in a randomize complete block design replicated thrice, having plot size of 5m x 3m. Row to row and plant to plant distances were kept at 75cm and 25 cm, respectively. Recommended dose of fertilizer was applied at planting. The experiment was harvested at physiological maturity. Analysis of variance was run for each location following Steel and Torrie (1980) as well as for the pooled data following Eberhardt and Russell (1966).

In order to measure the genotypic stability and magnitude of G x E interaction a number of statistics such as genotype mean performance ($\bar{Y}_i$) over locations, genotypic variance (S_i^2), genotypic coefficient of variation (CV%), ecovalence (W_i^2) and regression coefficient (b_i) as proposed by Eberhardt and Russell (1966) were estimated.

Results and Discussion

Genotype EV-5098 gave the highest mean grain yield of 2495 Kg ha^{-1} followed by EV-5089 (2211 Kg ha^{-1}), while the lowest mean grain yield of 1741 Kg ha^{-1} was obtained from EV-1089. The highest mean yield was obtained at location-1 (2429 Kg ha^{-1}) followed by location-2 (2182 Kg ha^{-1}) whereas the lowest mean yield of 1774 Kg ha^{-1} was obtained at location-3 (Table 1).

Analysis of variance for maize genotypes (Table 2) revealed that the genotypes showed highly significant differences (P< 0.01) in their yield performance at all locations. Rastogi and Rastogi (1998) found significant differences in grain yield and other characters in maize genotypes grown at different locations.

Combined analysis of variance over locations (Table 3) showed that the difference among genotypes and locations as well as genotype x environment interactions were highly significant. Alvarez and Ruiz (1999) also reported highly significant differences for genotypes, environment and G x E interaction in the combined analysis of variance for grain yield, while the significant differences due to genotype, environment and G x E interactions were observed by Gautam *et al.* (1998). Whereas Parag *et al.* (2000) reported significant differences due to genotype x environment interaction for grain yield. Significant genotype x environment interaction may influence the progress that a breeder can make in his program if cultivars are to be adapted to specific environments.

One of the most frequently used stability measures is based on the regression model (Eberhardt and Russell, 1966). The stability statistics in this instance is the slope, b_i, of the linear regression of the yield, $\bar{y}_{ij}$, of genotype i in environment j on the mean yield $\bar{y}_j$ of all the genotypes in environment j. Thus the mean yield at the environment j serves as an index of the overall yield potential at that environment. This statistic is also dependent on the other genotypes included in the test and should not be taken as a general measure of stability. With this statistic a genotype which has a slope of $b_i = 1$ is most stable over the environments in the trial as determined by the other genotypes included in the trial.

Francis and Kannenberg (1978) pointed out that the slope provides an indication of regions of adaptability as well as stability. Genotypes, which have a slope significantly greater than 1 are specifically, adapted to high yielding environments. On the other hand genotypes with a slope less than 1 are comparatively insensitive to change in environment and are therefore better adapted to low yielding environments. In this context the genotypes EV-5089 and EV-6098 (Table 4) having a regression slope > 1 are considered better for high yielding environments, whereas genotypes EV-5098 and EV-1089 with the regression slope < 1 would prove better for low yielding environments. The genotypes EV-1098 and EV-6089 proved their stability over the tested environments by

Table 1: Grain yield of Maize genotypes (Kg ha^{-1}) grown at different Locations of Barani areas during kharif 2000

Genotypes	Location 1 Hazro	Location 2 Hasanabdal	Location 3 Gujar Khan	Location 4 Kotli Satian	Mean
EV-5089	2569	2371	1828	2075	2211
EV-5098	2717	2668	2174	2421	2495
EV-1089	2075	1778	1630	1482	1741
EV-1098	2371	1927	1778	1581	1914
EV-6089	2322	2075	1630	2025	2013
EV-6098	2519	2272	1606	2223	2155
Mean	2429	2182	1774	1968	2088
LSD 5 %	239.1	173.3	174.9	178.2	
LSD 1 %	340.2	246.5	248.8	253.4	

Table 2: Mean squares of Maize genotypes grown at different locations during kharif 2000

S.O.V	d.f	Hazro	Hasanabdal	Gujar Khan	Kotli Satian
Reps.	2	12032.39 N.S	5600.67 N.S	6080.17 N.S	5830.17 N.S
Genotypes	5	150407.7 **	311824.1 **	139576.4 **	402538.1 **
Error	10	17279.59	9071.67	9244.37	9589.17
Total	17				

N.S = Non Significant
** = Significant at 1% level of probability

Table 3: Combined analysis of variance over locations

S.O.V	D.F	Mean squares
Locations	3	1426565.056 **
Reps. within location	8	7385.847 N.S
Genotypes	5	818962.822 **
Location x genotype	15	61794.489 **
Error	40	11296.197
Total	71	

Table 4: Statistical Parameters for different Maize Genotypes

Statistical Parameters	EV-5089	E.V-5098	E.V-1089	E.V-1098	E.V-6089	E.V-6098
Genotype mean ($\bar{y}_i$)	2210.75	2495.00	1741.25	1914.25	2013.00	2155.00
Genotype variance (S_i^2)	106316.24	62576.67	64108.90	112800.90	82052.67	150736.70
C.Vi %	14.75	10.03	14.54	17.55	14.23	18.02
Ecovalence (W_i^2)	9730.00	20634.00	63625.00	96892.00	24302.00	93385.00
Regression slope (b_i)	1.15	0.847	0.771	1.007	0.966	1.258

producing a regression slope close to 1 (Table 4).

In most breeding programs the breeder is interested in a particular set of genotypes and in how they perform over a range of environments. From the selections under test, he is interested in those which have a high yield and which are relatively stable over the environments tested. For this purpose he should look for a high mean yield $\ddot{Y}_{i.}$ a relatively low ecovalence W_i^2 (low contribution to the genotype x environment interaction) and a slope b_i of a linear regression on the environmental index, which is close to 1.00 (Petersen, 1989). The results (Table 4) indicated that genotype EV-5098 showed highest mean yield (2495 Kg ha^{-1}) with relatively low ecovalence (20634), whereas the genotype EV-5089 ranked second in mean yield (2211 Kg ha^{-1}) but showed lowest value of ecovalence (9730). Reviewing the results based on G x E interaction and stability parameters, the genotypes EV-5098 and EV-5089 may be considered relatively less sensitive to environmental changes and can successfully be grown over varied soil and climatic conditions.

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