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# STABILITY FOR GRAIN YIELD IN WHEAT

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**Abstract**

Genotype X environment interactions and relative stability for grain yield were studied in four durum wheat, one bread wheat and one triticale genotype grown at 5 locations. The yield ranking of the varieties varied across the environments. Both linear and non-linear components of genotype X environment interaction were significant, indicating genetic differences among 6 genotypes for both linear and non-linear response to varying environments. D-88678 and Wadanak-85, being high yielding with unit regression and non-significant non-linear deviation from regression were identified to be most stable and adaptable genotypes.

## Introduction

Consistency in yield has always been a problem in crop production due to the strong influence of environmental effects during the various stages of crop growth (Bull *et al.*, 1992). Genotype X environment interactions are therefore, of major concern to plant breeders for developing commercial varieties. Many workers described the importance of genotype X environment interaction and concluded that mean yields are not a satisfactory basis and emphasis should therefore be given on the evaluation of genotypes which could perform better irrespective of environmental fluctuations (Golmirzaie *et al.*, 1990; Kinyua, 1992; Liu, *et al.*, 1992; Qari *et al.*, 1990). A study of genotype X environment interaction can lead to successful evaluation of wheat cultivars for stability in yield performance across environments. In the presence of significant genotype X environment interactions, stability parameters are estimated to determine the superiority of individual genotypes across the range of environments. Genotype X environment interaction can be partitioned into components using regression analysis. This method was first proposed by Yates & Cochran (1938) and later modified by Finlay & Wilkinson (1963), Eberhart & Russell (1966) and Perkin & Jinks (1968). It involves measures of the regression coefficients and deviations from linear regression.

With a view of determining the information required for decisions on discarding or releasing new genotypes as varieties, data from 5 different locations were examined for different stability parameters. Since a stable variety is desirable for its commercial exploitation over a wide range of agro-climatic conditions, the present investigation could be of great significance to evaluate the advance genotypes for yield stability before their release as commercial varieties.

**Table 1. Yield performance (Kg/Ha) of six wheat Genotypes under Five Locations during, 1991-92.**

| Sr. No. | Variety/ line | Faisalabad Location-1 | Sheikhupura Location-2 | Hafizabad Location-3 | Khanewal Location-4 | Mianwali Location-5 | Genotype Average |
|---|---|---|---|---|---|---|---|
| 1. | T-89702 | $3398^{c}$ | $3467^{b}$ | $3654^{a}$ | $4063^{c}$ | $2885^{ab}$ | $3493^{c}$ |
| 2. | D-88678 | $4204^{ab}$ | $4083^{a}$ | $3792^{a}$ | $5594^{ab}$ | $2792^{ab}$ | $4093^{a}$ |
| 3. | D-87661 | $4500^{a}$ | $3292^{b}$ | $3706^{a}$ | $5417^{b}$ | $2875^{ab}$ | $3958^{a}$ |
| 4. | D-89615 | $3611^{c}$ | $3300^{b}$ | $3800^{a}$ | $5354^{b}$ | $2729^{b}$ | $3759^{b}$ |
| 5. | Wadanak-85 | $4065^{b}$ | $3479^{b}$ | $3779^{a}$ | $5719^{a}$ | $3042^{a}$ | $4017^{a}$ |
| 6. | Pak.81 | $3417^{c}$ | $3313^{b}$ | $3688^{a}$ | $5583^{ab}$ | $3000^{ab}$ | $3800^{b}$ |
| Loc. Average | | $3866^{b}$ | $3489^{c}$ | $3736^{b}$ | $5288^{a}$ | $2887^{d}$ | |

Means having same letters do not differ significantly ($P<0.05$) using DMR test.

## Materials and Methods

Four genotypes of durum wheat (D-87661, D-88678, D-89615, Wadanak-85), one triticale (T-89702) and one of bread wheat (Pak- 81) were grown at 5 locations viz., Faisalabad, Sheikhupura, Hafizabad, Khanewal and Mianwali, having different agro-climatic conditions, during winter 1991-92. Experiments were laid under randomized complete block design with 4 replications. Each entry was planted in a plot having 6 rows of 6 m length and 30 cm apart. Sowing was done from mid to late November 1991 with normal seed rate (100 kg/ha) and fertilizer dose (100N:75P kg/ha). Normal agronomic and cultural practices coinciding with the local requirements were applied at each location. Data for grain yield per plot (g) was taken from central 4 rows leaving 0.5m from both sides of each row of the plot and converted to Kg/ha. The data thus obtained over replications was subjected to environment wise analysis of variance followed by pooled analysis where genotypes were considered as fix variable and environments as random (Steel & Torrie, 1980). Responses of the genotypes to varying environments were analyzed by using Eberhart & Russell model (1966). A regression coefficient and the deviations from regression were obtained as parameters of stability. The hypothesis that $b_i = 1$ was tested by t-test and an approximate F- test was made to determine whether $S^2d_i$ for each genotype were significantly different from zero.

## Results and Discussion

Differences in yield performance of 6 genotypes were highly significant for all locations except location-3 (Table 1). Mean differences between genotypes and environments were highly significant ($P<0.01$) indicating substantial variability among both for grain yield. Highest yield was obtained at location-4 (5288 Kg/ha) followed by location-1 (3866 Kg/ha) and location-3 (3736 Kg/ha), while lowest was recorded at location-5 (2887 Kg/ha).

**Table 2. Pooled analysis of variance for grain yield in six wheat genotypes.**

| Source of variation | D.F. | Mean squares |
|---|---|---|
| Genotypes (G) | 5 | 236428.8** |
| Environments (E) | 4 | 4708872.0** |
| Env. + (G x E) | 24 | 4823684.8** |
| Environments (Linear) | 1 | 18835480.0** |
| G X E (Linear) | 5 | 234131.2* |
| Pooled deviations | 18 | 82531.3* |
| " " T-89702 | 3 | 36802.7 |
| " " D-88678 | 3 | 84886.7 |
| " " D-87661 | 3 | 126319.1* |
| " " D-89615 | 3 | 19871.8 |
| " " Wadanak-85 | 3 | 15746.3 |
| " " Pak.81 | 3 | 91561.1 |
| Pooled error | 75 | 44947.1 |

* = $P<0.05$ & ** = $P<0.01$

Yield ranking of genotypes varied with different environments. D-87661 (4500 Kg/ha) was top yielder at location-1. D-88678 (4204 Kg/ha) was at top under location-2 and stood second at location 1,3 and 4. Wadanak-85 showed highest yield performance at location 4 and 5 but got 3rd place at location 1 and 3. Similarly, the ranking of other genotypes varied under different environments (Table 1) indicating differential response of genotypes to different environments.

Pooled analysis of variance (Table 2) reflected the presence of significant ($P<0.01$) genotype X environment interaction as shown by the item genotype +

**Table 3. Estimates of stability parameters for Grain yield in six wheat genotypes.**

| Genotypes | Mean yield (Kg/ha) | % difference from average | Regression coefficient ($b_i$) | Variance due to deviation from reg. ($S^2d^-$) |
|---|---|---|---|---|
| T-89702 | 3493 | -9.34 | $0.444^{*} \pm 0.11$ | -8144.41 |
| D-88678 | 4093 | 6.23 | $1.099 \pm 0.16$ | 39939.58 |
| D-87661 | 3958 | 2.73 | $1.089 \pm 0.20$ | 81372.02* |
| D-89615 | 3759 | -2.44 | $1.097 \pm 0.08$ | -25075.25 |
| Wadanak-85 | 4017 | 4.26 | $1.150 \pm 0.07$ | -29200.83 |
| Pak.81 | 3800 | -1.38 | $1.120 \pm 0.17$ | 46614.01 |

** = $P<0.05$

(genotype X environment). These differences exhibited the differential response of genotypes in various environments. Partitioning of genotype X environment interaction into linear [GxE (linear)] and non-linear (pooled deviation) components revealed that both were highly significant and thus important in determining genotype X environment interaction. Similar findings have also been reported in wheat by Liu *et al.*, (1992) and in chickpea by Khan *et al.*, (1988).

Finlay & Wilkinson (1963) used linear regression as a measure of stability. Eberhart & Russell (1966) and Paroda & Hayes (1971) considered both regression coefficient ($b_i$) and deviation from regression ($S^2d^-$) for the estimation of phenotypic stability. In Eberhart & Russell model (1966), stability parameters are defined by the model,

$$Y_{ij} = \mu_i + \beta_i I_j + \delta_{ij}$$

where $Y_{ij}$ = Mean of the ith genotype at jth environment.
$\mu_i$ = Mean of the ith genotype over all environments.
$\beta_i$ = Regression coefficient of the ith genotype.
$I_j$ = Environmental index.
$\delta_{ij}$ = Deviation from regression.

Eberhart & Russell (1966) suggested that a genotype may be said to be stable over different environments if it shows unit regression coefficient (bi) with low deviation (non-significant) from the linear regression ($S^2d^-$). With these conditions, high and desirable Per Se performance of a variety over environments is also a positive point to rate the variety as a better and stable genotype. In the present investigation, the regression coefficient are close to unity in all the genotypes except T-89702 (0.444). Three genotypes viz., D-88678, Wadanak-85 and D-87661 gave above average yield performance (Table 3). Out of these three genotypes, D-87661 had high value of $S^2d^-$ making its performance unpredictable under varying environments and thus it is unsuitable for wide range cultivation. The top yielding genotype, D-88678 showed unit regression coefficient (1.099) and non-significant deviation from linearity (Table 3). Wadanak-85 also showed above average yield performance, unit regression and non-significant deviation from regression. These two genotypes were identified desirable through Eberhart & Russell model (1966). D-88678 may be considered as future durum wheat variety for cultivation in the Punjab province. Since stability in yield performance is genetically controlled (Eberhart & Russell, 1966; Perkin & Jinks, 1968), Wadanak-85 may be used successfully in breeding programme for developing high yielding stable cultivars.

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