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Analysis of Wheat Genotypes for Yield Stability in Rainfed Environments

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Abstract: Nine genotypes of wheat developed for rainfed areas of Pakistan viz., DN-18, NRL-9822, NR-200, V-99166, 98C013, V-3, PR-72, NR-181 and SN-7 were evaluated for stability of grain yield under seventeen diverse rainfed environments. The interaction between the genotypes and environments (G X E interaction) was used as an index to determine the yield stability of genotypes under all the environments during 2001-02. 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. The genotype V-99166 was the most adapted showing considerable good performance in the entire set of environments under study.

Key words: Bread wheat, genotypes, stability, rainfed environments

Introduction

Pakistan has varied agro-climatic regions including high mountainous valleys and irrigated plains. In the rainfed ecologies environmental factors such as, temperature and rainfall play an important role in the varietal performance along with edaphic factors like fertility status and soil characteristics. Increasing wheat yield has been (and probably will be) the chief objective of the Plant Breeders. The assessment of yield stability (or its opposite: yield variability) can be approached in various ways. Two of the most frequently used techniques are the Finlay and Wilkinson (1963) evaluation of the regression coefficient in the relationship between cultivar yield and environmental index and the method proposed by Eberhart and Russell (1966) which considers the deviation from the regression evaluation developed by Finlay and Wilkinson (1963). According to Eberhart and Russell (1966), a variety is stable if it has a unit regression over the environments (b=1.00) and minimum deviation from regression (S^2d_i-=0). Therefore, a variety with high mean yield over the environment, unit regression coefficient (b=1.00) and deviation from regression as small as possible (S^2d_i-=0) will be a better choice as a stable variety.

The stability parameters studied in three cereals by Yue *et al.* (1990) indicated that wheat crop in general was more stable in yield than maize and sorghum. G X E interaction has been reported in maize (Aslam *et al.,* 1988), rice (Qayyum *et al.,* 2000), mash (Zubair *et al.,* 2002), mungbean (Zubair and Ghafoor, 2001) and wheat (Asif *et al.*, 2003), but very little information is available on stability of rainfed wheat varieties. Thus, this study was undertaken to evaluate 9 wheat genotypes for their yield stability under diverse rainfed ecologies of Pakistan.

Materials and Methods

The experimental material comprised of nine advance rainfed lines or candidate varieties (DN-18, NRL-9822, NR-200, V-99166, 98C013, V-3, PR-72, NR-181 and SN-7) developed by various Plant Breeders in the country. All the material was evaluated at seventeen locations representing different climatic conditions in the country during 2001-02 (Table 1). At each location the trial was conducted in Randomized Complete Block Design with four replications. The experimental plots consisted of six rows of four meter length. Row to row distance was 30 cm. Stability parameters were worked out as suggested by Eberhart and Russell (1966), using computer software written by P. Chatwachirawong, Department of Agronomy, Faculty of Agriculture, Kasetsart University, Thailand in Q-Basic.

Table 1: Rainfed locations of Pakistan where nine genotypes of wheat were tested

Area	Location
Upland of Balochistan	Agricultural Research Institute, Sariab, Quetta
Upland of Balochistan	Arid Zone Research Center, Quetta
Upland of Balochistan	Kudd-e-Bashmi Kalat
Southern Punjab	Adaptive Research Farm, Karore, Layyah
Central Punjab	Seed Corporation Farm Piplan
Northern Punjab	Adaptive Research Farm, Gujranwala
Northern Punjab	Adaptive Research Farm, Kot Nainan, Shakargah
Northern Punjab	Tobacco Research Station, Kunjah
Northern Punjab	Barani Agricultural Research Institute, Chakwal
Northern Punjab	University of Arid Agriculture, Rawalpindi
Northern Punjab	National Agricultural Research Centre, Islamabad
Southern parts of NWFP	Agricultural Research Institute, D.I.Khan
Southern parts of NWFP	Arid Zone Research Institute, D. I. Khan
Plains of NWFP	Nuclear Institute for Food and Agriculture, Tarnab, Peshawar
Plains of NWFP	Cereal Crop Research Institute, Pirsabak
Northern parts of NWFP	ARS-Baffa Mansehra
Foot Hills of AJK	Garhi Dupatta Muzaffarabad, AJK

Results and Discussion

Pooled analysis of variance showed highly significant differences among the genotypes and environments for grain yield (Table 2), indicting the presence of variability among the genotypes as well as environments under study. The genotype x environment (G X E) interaction was further partitioned into linear and non linear components. Mean squares for these components were found significant indicating the presence of both predictable and unpredictable components of "G X E" interaction. The G X E (linear) interaction was highly significant when tested against pooled deviation, which revealed that there were genetic differences among genotypes for their regression on the environmental index. Finlay and Wilkinson (1963) considered linearity of regression as a measure of stability. Eberhart and Russell (1966) emphasized that both linear (b_i) and non linear components of G X E interaction should be considered in judging the phenotypic stability of a particular genotype. 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 simultaneous consideration of three parameters of stability (Table 3) for the individual genotype revealed that the genotype V-99166 showed regression closer to unity, grain yield above the average and low deviation from regression. Hence this genotype may be considered as stable genotype. Although the genotype NRL-9822 was higher yielding but it showed high b_i (regression) value along with high deviation from regression and hence may be considered for some specific environment. The genotypes DN-18, 99C013, V-3 and SN-7 had regression values with varying degrees and below average deviations. The mean yield performances of these genotypes were lower than the grand mean, indicating average stability with poor adaptation to environment fluctuations. The genotypes PR-72 and NR-181 produced more grain yield than the average yield of all the genotypes with regression value of more than 1.0 indicating sensitivity to environmental changes but giving higher yield when the environments were conducive. The genotype NR-200 would be especially good for unfavorable environments. It had slightly less grain yield than average with a low magnitude of b*i* and very high deviation from regression indicating less response to accidental changes in the environment.

Table 2: Pooled analysis of variance for grain yield in nine wheat genotypes

Source of variation	d.f.	M.S
Genotypes		135888.00**
Environment	16	11011800.00**
Genotype x Environment	128	174625.00**
Environment+(GXE)	144	1378755.50**
Environment (linear)	1	176188688.00**
G X E (linear)	8	171663.75**
Pooled deviation	135	99398.53*
Pooled error	456	60769.97

** Significant at 1% level, * Significant at 5% level

Table 3: Stability parameters for grain yield of wheat genotypes grown at seventeen rainfed locations in Pakistan

Genotype	Mean	b_i	S^2d_i
DN-18	2667	1.013	153230.27
NRL-9822	2868	1.240	478881.47
NR-200	2729	0.963	252658.94
V-99166	2907	1.002	49356.54
98C013	2752	0.887	92219.07
V-3	2691	0.900	63122.54
PR-72	2805	1.062	74398.53
NR-181	2773	1.010	86956.66
SN-7	2641	0.924	143752.80
Average	2759	1.00	154952.98

Table 3 gives a summary of relationship between regression coefficients and mean yield for nine wheat genotypes. This can be used for selecting stable genotypes. The vertical lines are one standard deviation above and below the grand mean, while the horizontal lines are one standard deviation above and below the average slope (b=1.0). Dots in the center section represent NR-200, V-3, PR-72 and NR-181 revealing average stability but the genotypes (NR-200 and V-3) had the average yield below the grand mean and genotypes (PR-72 and NR-181) had the average yield above the grand mean. The V-99166 had higher response to management conditions and show high stability over environments. Contrarily NRL-9822 was the high yielder, its regression coefficient identified it as below average stable indicating that it was specifically adapted to favorable environments.

Thus on the basis of this study it can be concluded that the genotype V-99166 was the most adapted and best suited under various rainfed ecologies of Pakistan.

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