ORIGINAL ARTICLE

Yield stability of spring wheat (*Triticum aestivum* L.) in the North West Frontier Province, Pakistan

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Abstract

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Ten promising wheat genotypes were evaluated for grain yield stability under varied environments at nine locations in the North West Frontier Province, Pakistan. The interaction between genotypes and environments (G x E) was found significant in this study. None of the regression coefficients (b_i) was significantly different from variety; therefore, stable performance of the genotypes could not be predicted on 'bi' alone. In this study, deviations from regression (S^2d) and average grain yields were used to identify the superior genotypes. Above average grain yields were observed in genotypes, CT-99022, SAW-98063, CT-99155 and Saleem-2000. Although cultivar Saleem-2000 produced high yield, on the basis of high S^2d value seemed to be sensitive upon environmental changes. Based on grain yield performance, low deviation from regression and b_i values the genotype CT-99022 is more suitable for favourable and CT-99155 for unfavourable environments. Stable performance was expressed by SAW-98063 because of higher grain yield, regression coefficient (b_i = .983) and low deviation from regression (S^2d = 0.065).

Key words : wheat genotypes, varied environments, stability analysis

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Plant breeders aim to develop new wheat cultivars that consistently have high yield in a variety of environments. The adaptability of a variety is usually tested by the degree of its interaction with different environments. A variety or genotype is considered to be more adaptive or stable if it has a high mean yield with low degree of fluctuation in yielding ability grown over diverse climatic conditions. Various statistical methods have been proposed to determine the stability of new cultivars. The most commonly used method is the joint regression analysis for yield stability (Finlay and Wilkinson 1963, Eberhart and Russell 1966). The regression coefficient (b_i) and the average departure from regression line (S^2d) are two mathematical indices for the assessment of stability (Eberhart and Russell 1966). A genotype with a high b_i and S^2d reacts readily to change in the environment and possesses considerable variability, whereas cultivars with a $b_i < 1.0$ and S^2d near to 0.0 react weakly to changes in growing conditions and are considered to be stable in yield (Shindin and Lokteva 2000). Finlay and Wilkinson (1963) regarded those genotypes with a b_i near 1.0 and high mean yield as being well adapted to all environments.

The genotype x environment interaction was studied by different researchers in various crops (Singh *et al*., 1987; Jain & Pandya 1988; Rao & Suryawanshi 1988; Ashraf *et al*., 2001; Zubair & Ghafoor, 2001). The stability parameters have also been studied in grain legumes for measuring phenotypic stability (Khan *et al*., 1987; Khan *et al*., 1988; Bakhsh *et al*., 1995, Sharif *et al*., 1998, Qureshi, 2001).

The current investigation was carried out to determine the potential of promising wheat genotypes for yield stability under different agro-climatic conditions.

Materials and Methods

Ten wheat genotypes / varieties were field evaluated at nine locations in the North West Frontier Province of Pakistan. The mentioned locations, i.e., DI Khan, Bannu, Peshawar, Malkandher, Pirsabak, Charsada, Mansehra, Gilgit and Mingora represent diverse climatic conditions. The experimental trials were conducted during Rabi season of 2003-2004, using randomized complete block design (RCBD) with four replications. Each genotype was sown in a 4 rows plot, 5-m long and 30 cm apart. Recommended doses of fertilizers and irrigations were applied during the growing period. At maturity, two central rows were harvested to record grain yield of each genotype. Stability parameters for grain yield were worked out as suggested by Eberhart & Russell (1966), using a computer software written in "BASIC".

Results and Discussion

The analysis of variance revealed that genotypes (G), environments (E) and the 'G x E' interaction mean squares were significant for grain yield (Table 2). Pooled analysis of variance showed highly significant differences among genotypes and environments (Table 3), indicating the presence of genetic and environmental variability among the studied genotypes. The G x E interaction was further partitioned into linear and non-linear (pooled deviation) components. Mean squares for both components were found highly significant, indicating that both predictable and un-predictable components shared G x E interaction. The linear interaction was highly significant when tested against pooled deviation, showing genetic differences among genotypes for their regression on the environmental-index. These results are in accordance with those of Finlay & Wilkinson (1963) and Perkins & Jinks (1968).

In the present investigation, the regression coefficients of all the varieties were not significantly different from unity. Therefore, the stable performance of the varieties in this case is predicted on the basis of other two parameters, i.e., deviation from regression and average yield over all the environments (Zubair *et al*., 2002).

The simultaneous consideration of three stability parameters for the individual genotype revealed that Saleem-2000, CT-99022, CT-99155,

Table 1. Variety code and Pedigree of wheat genotypes used in this study.

Genotypes/vars.	Parentage/Pedigree and selection history of Genotypes
CT-00184	OPATA/RAYON//KAUZ
SAW-98063	URES/JUN//KAUZ
SAW-98064	URES/JUN//KAUZ
CT-97413	ESDA/VEE#10
CT-99033	CHIL/2*STAR
CT-99022	URES/JUN//KAUZ
CT-00186	OASIS/SKAUZ//4*BCN
CT-99155	ATTILA/3/HUI/CARC//CHEN/CHTO/4/ATTILA
Bakhtawar-92	KAUZ 'S'
Saleem-2000	CHAM-6//KITE/PGO

Table 2. Pooled analysis of variance of grain yield (t/ha) in 10 wheat genotypes grown in 9 locations in the North West Frontier Province, Pakistan.

Source	DF	Mean Squares
Replications	3	2.787
Environments (E)	8	1.613
Genotypes (G)	9	10.261
E x G	72	1.029
Error	267	0.744

Table 3. Stability analysis of grain yield (t/ha) in 10 wheat genotypes grown in 9 locations in the North West Frontier Province, Pakistan.

Source of variation	Df	Mean Squares
Genotypes (G)	9	0.417**
Environment + (G X E)	80	0.492**
Environment (Linear)	1	20.608
G X E (linear)	9	0.436**
Pooled Deviation	70	0.221**
Pooled error	270	0.767

Table 4. Mean grain yields and estimates of stability parameters for yield of 10 wheat grown in 9 locations in the North West Frontier Province, Pakistan.

Genotypes	Mean yield (t/ha)	Regression coefficient (b_i)	Dispersion (S^2d)
CT-00184	3.7 -	0.621	0.392
SAW-98063	4.1 +	0.937	0.065
SAW-98064	3.9	0.672	0.236
CT-97413	3.8 -	0.823	0.131
CT-99033	3.5 -	1.082	0.601
CT-99022	4.2 +	1.593**	0.066
CT-00186	3.9 -	0.367	0.222
CT-99155	4.0 +	0.760	0.085
Bakhtawar-92	3.9	1.626**	0.096
Saleem2000	4.0 +	1.620*	0.150
Grand mean	3.9	1.00	

**** Significantly different from 1.0 at 0.01 level of probability**
*** Significantly different from 1.0 at 0.05 level of probability**
+ Variety having above average grain yield
- Variety having below average grain yield

SAW-98063 and Bakhtawar-92 gave the highest yield of 4.0, 4.2, 4.0, 4.1 and 3.9 t/ha over the grand mean yield with the regression coefficients 1.620, 1.593, 0.760, 0.937 and 1.626 respectively and not significantly different from regression (Table 4). Due to greater value of regression coefficient ($b_i > 1.0$), CT-99022 and Bakhtawar-92 are expected to give good yield under favourable environmental conditions. CT-99155 is specifically adapted to unfavorable environmental conditions having grain yield of 4.0 t/ha and a regression value less than one ($b_i < 1.0$) with non-significant standard deviation. Saleem-2000 was a high yielder (4.0 t/ha) but it had high value of S^2d showing sensitivity to environmental changes and an unpredictable grain yield (Eberhart and Russel, 1966). Genotype SAW-98063 had above average grain yield, regression coefficient close to one ($b_i = 0.983$) and with low deviation from regression revealed wide adaptation and stability for grain yield across the tested environments. Similar results were also reported by other investigators (Arain and Siddiqi, 1977; Sial *et al.*, 1999; Shindin and Lokteva, 2000).

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