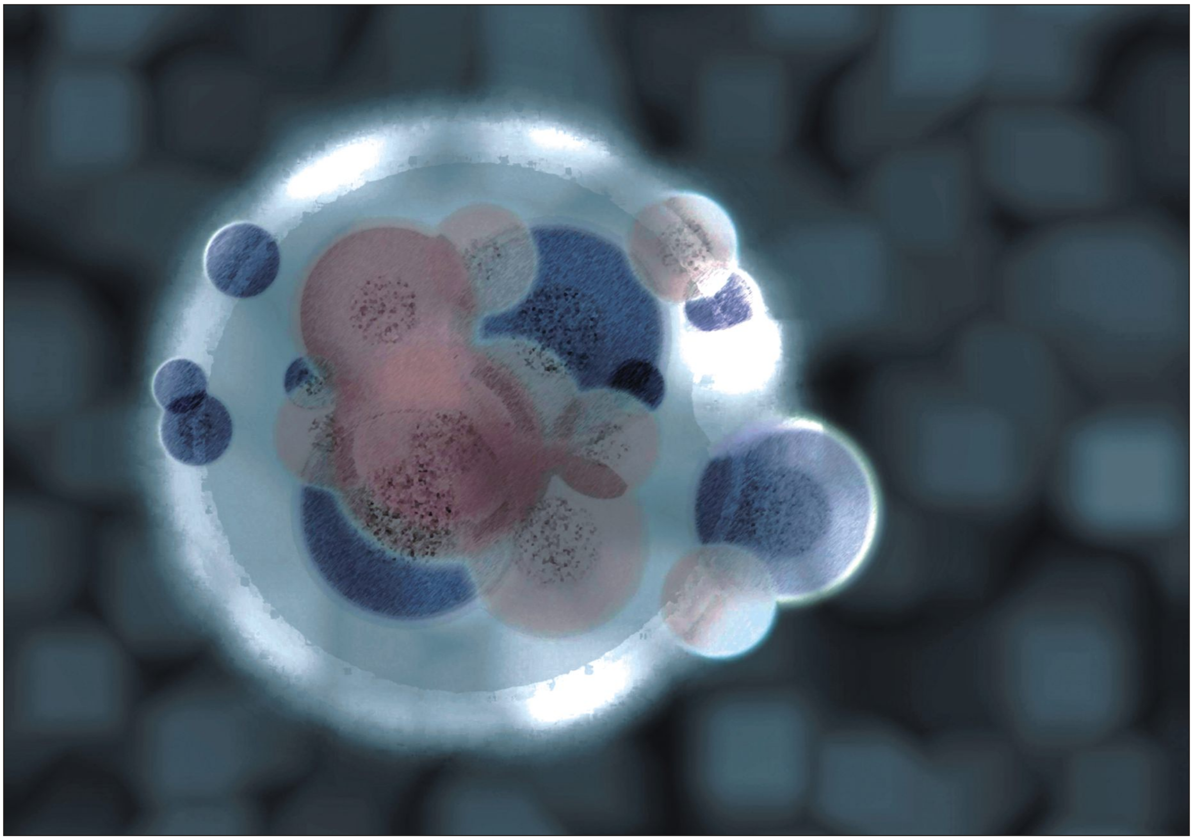

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Genotype-Environment Interaction in Wheat

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Abstract: Thirteen advance lines and three check varieties viz. , Chakwal-86, Pak-81 and Rawal-87 of wheat were planted at nine locations to estimate genotype x environment interaction. Both the linear and non-linear (pooled deviation) components were highly significant, indicating the presence of both predictable and un-predictable components of “G X E” interaction. The stability parameters for the individual genotype revealed that the genotypes, 89R-35 and 90R-36 showed the regression closer to unity along with low deviation from regression and thus may be stated as stable genotypes.

Key word: Wheat, stability, genotype environment interaction

Introduction

The adaptability of a variety over diverse environment is usually tested by the degree of its interaction with different environments under which it is grown. A variety or genotype is considered to be more adaptive or stable one if it has a high mean yield but low degree of fluctuation in yielding ability when grown over diverse environments. Eberhart and Russell (1966) proposed a model to test the stability of varieties under various environments. They defined a stable variety as having unite regression over the environments ($b_i = 1$) and minimum deviation from the regression ($S^2d_i = 0$). Therefore , a variety with a high yield over the environments, unite regression coefficient ($b_i = 1$) and deviation from regression as small as possible ($S^2d_i = 0$) , will be a better choices a stable variety.

The stability parameter studied in three cereals by Yue *et al*. (1990) indicated that wheat crop in general was more stable in yield than maize and sorghum. Similarly, Bakhsh *et al*. (1995) reported low stability in chickpea. The yield of some varieties in wheat were found more stable by Gogas (1989). Some investigation on stability parameters in barley is reported by Rasmusson and Lamhert (1961) and Verma *et al*. (1987). The yield of barley varieties vary widely in the Punjab province due to variation in soil and climatic factors which complicated identification of superior barley varieties (Qazi *et al*., 1990). Similarly the yield of wheat crop also fluctuate yearly in the rainfed areas of Punjab province, therefore the present investigation was planned to evaluate sixteen genotypes of wheat developed for rainfed condition for their yield stability under different agroclimatic conditions.

Materials and Methods

Sixteen genotypes including 13 advanced lines/candidate varieties and 3 checks, viz., Chakwal 86, Pak. 81 and Rawal 87 of wheat were planted under a wide range of agroecologcial conditions (Table 1). The advance lines were developed by various plant breeders working on wheat crop in the country. The yield performance of experiments was tested at nine locations throughout Punjab province, which represent different agroclimatic conditions of the Punjab. The experiment was conducted at each location during winter 1992-93 in a Randomized Complete Block Design with four replications. The experimental plots consisted of six rows of five meter length. Row to row distance was 30 cm and plants were spaced at 10 cm. Stability parameters for grain yield were worked out as suggested by Eberhart and Russell (1966), using a computer software written in "BASIC"

Results and Discussion

Pooled analysis of variance showed highly significant differences among the genotypes and environments for grain yield (Table 2), indicating the presence of variability among the genotypes as well as environments under which the experiments were conducted. The genotype X environment (G X E) interaction was further partitioned in to linear and non-linear (pooled deviation)components. Mean square for both these components were found highly significant, indicating the presence of both predictable and unpredictable components of "G X E" interaction. The G X E (linear)interaction, which revealed that there are 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), however, 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. 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 simultaneous consideration of three parameters of stability (Table 3) for the individual genotype revealed that the genotypes "89R 35 and 90R 36" showed the regression closer to unity along with low deviation from regression. Although the genotype "90C 013" was highest yielding but it showed high b value along with high deviation from regression and hence may be considered suitable for some specific area. "89R 35" was high yielding genotype (2541 kg ha^{-1}) with regression value 1.03 with a non-significant deviation from regression. Whereas, "90R 36" produced slightly lower grain yield than average and had b_i = 1.03 and non-significant standard deviation, indicating less response to environmental changes.

The genotypes, 91169, 91173 and 90C 007 produced more grain yield than the average yield of all the genotypes over all the environments. They had regression values more than 1.0, indicating sensitivity to environmental changes

Table 1: Locations where yield performance of 16 genotypes of wheat was tested

Site	Locations
Wheat Research Station, Rainfed, Rawalpindi	Northern Punjab
Wheat Research Institute, Faisalabad	Central Punjab
Barani Agricultural Research Institute, Chakwal	Northern Punjab
Regional Agricultural Research Institute, Bahawalpur	Southern Punjab
Arid Zone Research Institute, Bhakkar.	Southern Punjab
Agricultural Farm, Attock.	Northern Punjab
Agricultural Research Farm, Fetehjang, Attock	Northern Punjab
Rural Training Institute, Lalamusa, Gujrat.	Northern Punjab
Farmer's field, Gujrat.	Northern Punjab

Table 2: Pooled analysis of variance of grain yield (kg ha^{-1}) in 16 wheat genotypes

Source	DF	MS
Genotypes	15	4357440. 0**
Environment + (G X E)	128	18600490.0**
Environment (linear)	17492610.0**	
G X E (linear)	15	2477440. 0**
Pooled deviation	112	8601478. 0**
Pooled error	432	8794. 4

** Significant at the 1% level

Table 3: Stability parameters of 16 wheat Varieties grown in nine environments

Genotype	Mean	b_i	S^2d_1	No. In Fig. 1
89R 35	2541	1.03	158814	1
90R 02	2018	0.98	248757	2
90R 08	1912	0.67	1363056	3
90R 34	2447	0.93	842558	4
90R 36	2212	1.03	143963	5
89R 36	2290	1.00	1007881	5
91169	2398	1.07	834951	6
91173	2347	1.03	395664	7
90A 009	2112	0.85	332508	8
90A 351	2129	0.95	609693	9
90C 007	2318	1.03	368691	10
90A 013	2553	1.23	873515	11
90A 018	2113	1.15	441037	12
Chakwal 86	2160	0.96	346258	13
Pak 81	2220	1.02	414337	14
Rawal 87	2232	1.07	219795	16
Average	2250	1.00	537592	

but giving higher yield when the environments were conducive. Among these genotypes, 90C 007 showed less fluctuation to change in the environments. The genotypes, 90R 02, 90A 009, 90C 018, Chakwal 86, Pak. 81 and Rawal 87 had regression values with varying degrees and below average deviations. The mean yield performance of these genotypes were lower than the grand mean, indicating average stability with poor adaptation to environmental fluctuations.

The yield of cultivar 89R 27 was slightly more grain yield than the grand mean yield. It possessed average linear response but highly significant deviation from regression and thus, can be regarded as having below average stability with poor response to favorable conditions. The genotype 90R 08 had regression value less than unity with highly significant deviation values and this genotype had below average yield and their stability parameters revealed greater stability to environmental changes with specific adaptation to unfavorable environments.

Relationship between regression coefficient and mean yield for individual 16 wheat cultivars is shown graphically in Fig. 1. One standard dieviation above and below the mean in yield and average b_i are delineated by vertical and apparently in their responsiveness to environmental conditions. The identification of high

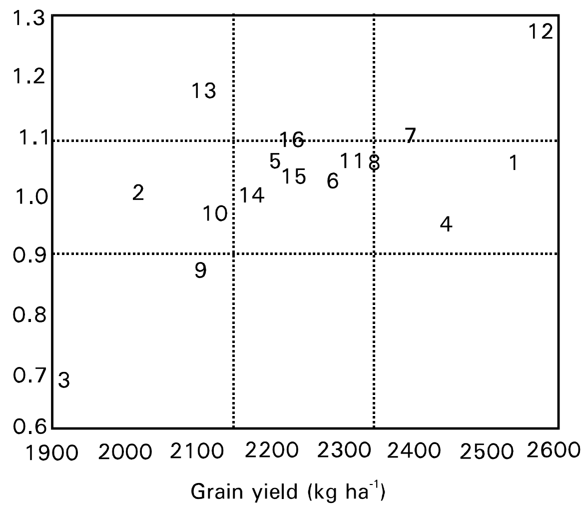

Fig. 1: Stability diagram of 16 wheat cultivars tested under 9 locations. For cultivar name please refer to Table 3. Cultivars in the box are stable ones

yielding genotypes that show high stability over environments or large response to more productive environment is of special interest. The genotypes, 89 R 36, 90C 007 and 91173 were above average mean yield and stable, whereas Rawal 87, Chakwal 86, Pak 81 and 90 R 36 were slightly lower in yield but stable. The genotype, 89 R 36 was observed stable for three stability parameters. Although deviation from regression was slightly higher for this genotype, but high grain yield and regression closed to unity favored this in determining stability.

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