Pak. J. Bot., 38(4): 1177-1183, 2006.

ADAPTATION AND STABILITY ANALYSIS IN THE SELECTED LINES OF TIR WHEAT

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Abstract

Genotype and environment (G x E) interactions are of major concern to plant breeders in breeding cultivars. The objective of this study was to determine the stability of grain yield in 12 wheat genotypes. Eleven lines selected from Tir wheat population (*Triticum aestivum*) were used in the study. The experiment was conducted in Van, Erciş, and Adilcevaz located in the eastern part of Turkey in 1997-98 and 1998-99. Two stability parameters were obtained as linear regression coefficient (b) of an entry mean on the average of all entries and deviation from regression (s^2d), then stability was tested with the hypotheses b = 1.0 and $s^2d = 0$. The results indicated that there were significant differences and interactions among genotypes, locations and years. The regression coefficient (b) values of the 11 genotypes used in this study ranged from 0.46 to 1.73; deviation from regression ranged from 69.9 to 2896.7. According to estimates of the two stability parameters, none of the genotypes were stable for grain yield. However, based on the linear regression coefficient and average grain yield, line 2 (Adilcevaz-40/1) and 11 (Van-Edremit/1) appeared to be promising because their yields were above the average in all of the environmental conditions of this study.

Introduction

Wheat is the most important cereal crop in Lake Van Basin in the eastern part of Turkey, but the average grain yield is half of the average yield of Turkey (Anon., 2000). Tir wheat, a population, has been cultivated for many years and has a significant role in Lake Van Basin. Drought and severe winter conditions are the most important environmental factors limiting wheat productivity in the region (Sönmez & Ülker, 1998). None of the domestic and foreign cultivars, including those introduced from ICARDA to Van region did not give yield as high as Tir wheat did (Ülker *et al*., 1994, 2000). Therefore, the development of wheat cultivars in Lake Van Basin has been the goal of our study. Tir wheat population, well adapted to Lake Van Basin, has different types for many characters which need to be studied in more details. Previous studies have mostly dealt with selection of lines with high yield and adaptation ability by using variation in this population well adapted to the environment of this region (Ülker *et al.* 1994) and promising lines were selected from Tir wheat populations (Sönmez & Ülker 1998; Sönmez *et al.* 1999). However, there is no information about responses of the selected lines to different environmental conditions because wheat production area is large and there are different environment conditions in Lake Van Base. Because of the environmental variations, decision on selection for grain yield is rather difficult. Therefore, yield response and stability of selected lines should be studied in different environmental conditions.

Environmental conditions are known to have significant influence on yield of wheat. But relative magnitude of environmental, genetic, and G x E effects on grain yield is unclear, and development of a selection strategy for grain yield requires knowledge of the magnitude of the genotype and environment (G x E) interaction. Plant breeders carry out performance tests at different locations in different years in target areas, and data obtained from these tests are used to determine the magnitude of G x E interactions. In the presence of G x E interactions, stability parameters are estimated to determine the superiority of individual genotypes across the range of environments.

Methods available for estimating the magnitude of G x E interactions involve an analysis of variance approach (Hanson *et al.* 1956; Comstock & Moll 1963). This method was first developed by Yates & Cochran (1938) and later modified by Finlay & Wilkinson (1963) and Eberhart & Russell (1966). Cultivars stability, as related to interactions between genotype and environment, can be described in components; 1- linear response to environmental yield potential and 2- deviations from that response (Eberhart & Russell 1966; Lin *et al.* 1986; Kang 1990). The preferred genotypes generally show lower genotype x environment (G x E) interaction variances and higher average response to environmental yield potential, and lower deviations from the expected response within a target production region (Peterson *et al.* 1997). These criteria have been widely used by plant breeders (Sharma *et al.* 1987; Peterson *et al.* 1992; Peterson *et al.* 1997). It provides useful parameter estimates when numbers of genotypes and environments considered in the analysis are sufficiently large and when there are no extreme environments (Peterson *et al.*, 1997).

The objective of this study was to evaluate the response and stability of eleven promising lines selected from Tir wheat population in Lake Van Basin.

Materials and Methods

Tir wheat population and 11 lines were grown at three different locations in Lake Van Basin in Turkey during 1997-98 and 1998-99. Locations used in each year were Van, Adilcevaz (Bitlis), and Erciş. The study was conducted in farmer fields that were fallow. Soil types were slightly alkaline (pH=7.35-7.52) and sandy-loam. The organic matter content at Van, Adilcevaz and Erciş locations were 0.46, 0.32 and 0.70 %; available phosphorus and salt levels were 5.58, 5.05, 12.6 ppm and 0.02, 0.03, 0.02 %, respectively.

Three locations had similar altitudes, but their precipitation, moisture and temperature traits were different. Overall average temperatures optimum at Van, Adilcevaz and Erciş locations were 8.8, 9.0, 7.9 °C, respectively. Average temperatures at the three locations in the second year of the study were higher than in the first year. Average temperatures at Van, Adilcevaz and Erciş locations were 9.8 in 1997-98 and 9.6 in 1998-99; 7.5 in 1997-98 and 11.2 in 1998-99; 11.5 in 1997-98 and 9.6 in 1998-99, respectively. Precipitations at three locations were below average in both of the seasons with higher precipitation in the first year. Adilcevaz location received higher precipitation than the other locations in both years.

Genotypes used in the experiment were Adilcevaz-60/6, Adilcevaz-40/1, Amik/3, Ahlat+10/10, Ahlat/4, Erciş –30/1, Erciş-60/1, Erciş-45/5, Özalp-5/12, Van/3, Van-Edremit/1 and Tir wheat population. These eleven lines were selected from Tir wheat population by Sönmez & Ülker (1998). Tir wheat population has been also cultivated over years successfully in Van region.

Randomized complete-block design was used in the experiment with three replications (Gomez & Gomez 1984). Each plot was eight rows, 7.00 m long and 0.20 m apart. The seeding rate was 400 viable seed/m². Nitrogen was applied @ 40 kg N/ha at sowing and 40 kg N/ha at stem elongation. Phosphorus was applied @ 40 kg P_2O_5/ha at sowing. All of the plots were sown between December 15 and October 10 in each year (Sönmez *et al*., 1998).

Grain yield was obtained from 6.00 m section of four interior rows in each plot. Plots were harvested using sickle. The grains were cleaned and weighed to determine grain yield.

The data were evaluated statistically as described by Eberhart & Russell (1966), where stability was defined as a function of slope and deviations from regression of entry yield on the environmental index. Year, location, replication, and their interactions were considered as random effects, while genotype was a fixed effect. Data were analyzed by analysis of variance using TARIST (Anon., 1997).

Results and Discussion

The values of variations for genotype, location, year, and their interactions are presented in Table 1. Genotype ($P<0,05$), location, year ($P<0,01$), and their interactions were significantly different for grain yield. In addition, genotypes for grain yield differed among the three locations and between the two years.

Table 1. Analysis of variance for grain yield for 12 wheat genotypes from three locations.

Source of variation	df	Sum squares	Mean squares	F-values
Year (Y)	1	504793.4	504793.4	215.70**
Location (L)	2	72563.1	36281.6	15.50**
Y x L	2	256153.9	128076.9	54.73**
Replication (YxL)	12	52912.6	4409.4	1.88*
Genotype (G)	11	59067.2	5369.7	2.29*
Y x G	11	57349.5	5213.6	2.23**
L x G	22	154399.9	7018.2	2.99**
Y x L x G	22	147444.9	6702.4	2.86**
Error	132	308918.1	2340.3	
Total	215	1613602.5	7505.1	

*P< 0.05 and **P< 0.01.

Overall mean values for grain yields ranged from 960 to 4703 kg/ha (Table 2). Mean values in grain yields varied between 1567 and 2217 kg/ha for genotypes, 1611 and 2058 kg/ha for locations, and 1339 and 2306 kg/ha for years. There were relatively large variation in grain yields; the variation in yields between years was notably higher compared to those in genotypes and locations.

Table 2. Means for grain yield of Tir wheat lines at there locations 1997-98 and 1998-99 (kg/ha).

	Genotypes	Van		Adilcevaz		Erciş	
		1997-98	1998-99	1997-98	1998-99	1997-98	1998-99
1.	Adilcevaz-60/6	1973	1187	2237	1213	1470	1790
2.	Adilcevaz-40/1	3180	1133	2380	1593	1520	1417
3.	Amik mrk./3	3270	960	1290	1353	1190	1343
4.	Ahlat +10/10	2643	1110	2000	1467	1803	1560
5.	Ahlat mrk./4	3957	977	1633	1593	1427	1070
6.	Erciş-30/1	4703	1383	2337	1580	1377	1923
7.	Erciş-60/1	4030	1037	1970	1080	2333	1690
8.	Erciş-45/5	3273	1030	2227	1067	1967	1387
9.	Özalp-5/12	2393	1217	2260	1720	1970	1377
10.	Van mrk./3	1887	1120	2680	1687	1247	1513
11.	Van mrk.Edt./1	2673	1033	2857	1327	2267	1267
12.	Tir	2083	1127	2257	1387	2250	1490
	Mean	**3006**	**1109**	**2177**	**1422**	**1735**	**1486**
	Mean for location	**2058**		**1800**		**1611**	

Table 3. Mean grain yield and estimates stability parameters in 12 wheat genotypes on 3 locations in 1997-98 and 1998-99.

	Genotypes	Grain yield (kg/ha)	b	S^2d
1.	Adilcevaz-60/6	1645	0.46	1041.6
2.	Adilcevaz-40/1	1871	1.10	286.8
3.	Amik mrk./3	1567	1.10	1974.2
4.	Ahlat +10/10	1764	0.77	69.9
5.	Ahlat mrk./4	1776	1.49	2387.7
6.	Erciş-30/1	2217	1.73	2896.7
7.	Erciş-60/1	2023	1.52	1860.9
8.	Erciş-45/5	1825	1.24	353.4
9.	Özalp-5/12	1824	0.62	546.6
10.	Van mrk./3	1689	0.47	2645.9
11.	Van mrk.Edt./1	1904	0.99	2193.3
12.	Tir	1766	0.52	1436.1
	Mean	**1822**		

The highest grain yield was obtained from line 6, while the lowest yield was obtained from line 3. Six lines (2, 6, 7, 8, 9, and 11) provided yields above the average yield. Tir wheat population provided lower grain yield (1766 kg/ha) than the overall average (1822 kg/ha) (Table 3), Miezan *et al.* (1979), Bhullar *et al.* (1983), and Sharma *et al.* (1987) also found significant differences in grain yields of different wheat genotypes in response to different environmental conditions.

Stability parameters were estimated by the method described by Eberhart & Russell (1966). This method defined a stable cultivar which had a regression coefficient of 1.0 and no deviation from regression mean square. However, according to Eberhart & Russell (1966), an ideal cultivar would have both a high average performance over a wide range of environments and stability. Becker *et al.* (1982) regarded mean square for deviation from regression to be the most appropriate criterion for measuring phenotypic stability in an agronomic sense because this parameter measures the predictability of genotypic reaction to environments. Langer *et al.* (1979) and Peterson *et al.* (1992) suggested that the regression coefficient was a measure of response to varying environments. Variances in genotype mean were used to evaluate stability of grain yield across locations, years and regression coefficients (b); deviations from regression (S^2_d) are presented in Table 3. Significant differences in genotype responses to environments were observed in the linear regression coefficients (b-values) for grain yield (Table 3). The regression coefficient (b) values of the twelve genotypes used in this study ranged from 0.46 to 1.73 (Table 3) and there was no genotype with b-values equal to 1.0. The variations in b-values suggested that the 12 genotypes responded differently to the different environments. Variability among environments is an important factor and mostly determines the usefulness of b values (Pfahler & Linskens 1979; Sharma *et al.* 1987). The regression coefficient values of lines 2, 3 and 11 were close to 1.0. Line 6 had the highest (1.73) regression coefficient, followed by lines 7 (1.54), 5 (1.49) and 8 (1.24). The yields of these lines were affected by varying environmental conditions significantly and yields increased when the condition were adequate and decreased to below average when the conditions were inadequate. Regression coefficient (b) values of the other genotypes ranged from 0.46 to 0.77. Lines 1, 4, 9, and 10 had b-values <1.0. The regression coefficient (b) values of Tir wheat population, the check, was b= 0.52.

One of the important criterion that has been frequently used by plant breeders is deviation from regression (Sharma *et al.* 1987; Korkut & Başer 1993; Peterson *et al.* 1997). The regression analysis showed that there were wide ranges of deviations in genotypes. None of the genotypes were adequate for $s^2d = 0$ and deviations from regression ranged from 69.9 to 2896.7. The highest value for deviation from regression was obtained from line 6 (2896.7); the lowest value was obtained from line 4 (69.9) Deviations from regression for Tir wheat population was 1436.1 (Table 3).

Line 6, that provided the highest grain yield, had the highest b (1.73) and s^2d (2896.7) values. Regression coefficient values of line 2 and 11 that provided grain yield above the average were 1.10 and 0.99, respectively and these were the nearest values to 1.0. Regression coefficient value of line 3 was near 1.0, but yield was below the average. Hence, based on the estimates of the two stability parameters, none of the genotypes appeared to be stable for grain yield. However, based on the linear regression coefficient and the average grain yield, line 2 and 11 were promising because they had higher yields than the average in all of the environmental conditions evaluated in this study. Smith (1982), Korkut & Başer (1993) and Özgen (1994) considered that a desirable genotype with stability and above average grain yield should have a regression line with a positive intercept and slope equal to 1.0.

Conclusion

The results of this study indicated that grain yield was significantly influenced by changes in environmental conditions because there were significant variations in grain yields of the genotypes tested in response to the environment. Of the 12 genotypes tested, two genotypes (Line 2 and 11) represented stability trends for grain yield. Tir wheat population had yield below the average and it did not appear to be stable in grain yield.

Therefore, breeding studies should be continued and new cultivars resistant to severe winter and drought conditions should be studied to increase grain yield in the region.

Acknowledgments

The authors thank to TUBITAK (The Scientific and Technical Research Council of Turkey) for its financial support in this study (TOGDAG-1729).

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(Received for publication 10 January 2002)