J. Agr. Sci. Tech. (2016) Vol. 18: 553-560

Stability Performance of Bread Wheat (*Triticum aestivum L.)* Lines

P. O. Kurt Polat[1*], E. A. Cifci[1], and K. Yagdı[1]

ABSTRACT

The primary aim of plant breeding is to improve stability in yield and to obtain varieties with good quality. For this reason, a study of wheat varieties was conducted in 2010, 2011, and 2012 at the Agricultural Application and Research Center fields of the Uludag University, Agricultural Faculty, in Bursa/Turkey. In the study, 22 advanced lines of bread wheat and Gonen, Pehlivan, and Flamura cultivars as controls were examined in a 3-year experiment. In each year, the experiment was conducted in randomized block design with three replications. The effects of cultivars, environment, and genotype×environment interactions were evaluated. Results of the study permitted us to distinguish three lines, namely, (Gx22-1)-4, (Gx22-1)-6, and (GxK) which were characterized by higher adaptation capabilities and stability than those of the other genotypes.

Keywords: Adaptation, Breeding lines, Genotype×environment interactions.

INTRODUCTION

Wheat is a source of nutrition for 35% of the world population, and currently ranks first among cultivated plants in terms of cultivation area and production. Wheat is used for both human and animal nutrition and plays an important role in the nutrition of rapidly growing populations both in our country and the world (Yagdi, 2002).

Turkey has various climatic zones due to its geographical and topographical characteristics. Many agricultural systems specific to particular agro-ecological regions have emerged in these zones. Highly-productive cultivars have recently been developed in areas with extensive wheat cultivation. Moreover, a substantial number of 50-60-year-old cultivars with low productivity remain uncultivated (Sahin *et al*., 2006; Altay, 2012). The area available for wheat cultivation is becoming increasingly limited, but the demand for wheat continues to grow. For this reason, it is of vital importance to select appropriate cultivars, suitable for growing in the area, that offer maximum efficiency per unit area. Both the yield of the cultivars used in a region and the stability of their performance under the particular environmental conditions of the culture are crucial features of the cultivars used commonly in the region, as they are essential to ensure continuous productivity (Yagdi, 2002).

As in the case of other plants, obtaining high yields from wheat cultivation depends on the developments and cultivation of cultivars suitable for particular ecological conditions. The basic cause of differences between genotypes in their yield stability is the wide occurrence of Genotype×Environment (GE) interactions, i.e. the ranking of genotypes depends on the particular environmental conditions where they are grown (Becker and Leon, 1988). Therefore, GE interactions are the primary

[1] Department of Field Crops, Faculty of Agriculture, University of Uludag Turkey, 16059 Nilüfer, Bursa, Turkey.
[*] Corresponding author; email: ozlemkurt26@hotmail.com

factors that concern plant breeders in the development of the cultivars.

The principal objective of plant breeding is to improve stability in yield and to develop varieties of good quality. If GE interaction causes a change in yield, then the work of plant breeders becomes increasingly significant in terms of the effectiveness of the selection and recommendation of cultivars for different regions (Huehn, 1990). For this purpose, various methods of stability analysis have been proposed and developed by biometriciants and breeding researchers. Yates and Cochran (1938) discussed using joint regression analysis of either phenotypic values or their interactions on environmental indices.

This approach was later modified by Finlay and Wilkinson (1963) and Eberhart and Russell (1966). Genotype stability is partly expressed in terms of three empirical parameters: the mean performance, the slope of the regression line (bi), and the sum of the Squares deviation from regression (S^2_{di}). Wricke (1962) suggested using Genotype×Environment Interactions (GEI) for each genotype as a stability measure, which he termed ecovalence (W^2_i). Shukla (1972) developed an unbiased estimate using the stability variance (σ^2_i) of genotypes and a method to test the significance of (σ^2_i) to determine the stability of a genotype. Francis and Kannenberg (1978) used the environmental variance (S^2_i) and the Coefficient of Variation (CV_i) of each genotype as stability parameters.

This study was conducted with the aim to define adaptation and stability parameters for 22 breeding lines and three commonly cultivated wheat cultivars in Bursa/Turkey by using means, regression coefficients (b), and deviation mean squares for grain yield.

MATERIALS AND METHODS

This study was conducted in the field of Uludag University, Faculty of Agriculture, Agricultural Application and Research Centre in Bursa during 2009-2012 seasons. This experimental area is located in the coastal zone of northwest Turkey (40° 11' North, 29° 04' East), 70 m above sea level. Material for the study consisted of 22 advanced breeding lines of bread wheat (*Triticum aestivum* L.) and three cultivars, namely, Gonen, Pehlivan, and Flamura as the controls. Planting dates were in November 5th and 6th throughout the three years trials . In each year, the experiment was carried out in the randomized complete block design with 3 replications. Plot sizes were 5×1.2= 6 m^2 at planting and at harvest. Seeding rate was 550 seeds m^{-2} in all experiments. Sixty kg P_2O_5 ha^{-1} and 50 kg N ha^{-1} were applied at planting, and additional 100 kg N ha^{-1} was applied in the early spring. Weeds were chemically controlled in the spring. The grain yield per plot was measured and expressed as grain yield per decare (= 0.1 ha).

Two way analysis of variance was used to evaluate the yearly difference for the studied genotypes and the GEI. Differences between means for cultivars and lines were determined by *LSD* method (Turan, 1995).

The differences in the means of yield of the genotypes were determined for each year based on the overall average and used as the index value for that corresponding region. Adaptation values were determined from the means of each genotype for the regression coefficient associated with the environmental index, and stability values were estimated from the quadratic mean of the regression deviation (Finlay and Wilkinson, 1963; Eberhart and Russell, 1966; Yagdi, 1998).

The climate of Bursa Province, where the experiments were conducted, is intermediate between the Mediterranean and Black Sea climates. The province has mild winters, and severe drought is uncommon (Anonymous, 2010). Long-term climate data and the rainfall and temperature values for 2009-2012 for Bursa Province are given in Tables 1 and 2.

The long-term average temperature for Bursa Province is 15.3°C. The average temperatures during the first and third years

Table 1. Long-term monthly averages and average monthly temperatures (°C) during the study period in Bursa Province.

Month	1970-2011	2009	2010	2011	2012
January	7.9	6.1	6.6	5.8	3.1
February	7.6	7.2	9.4	6.1	3.6
March	6.7	8.8	9.0	8.2	7.2
April	13.0	12.3	13.5	10.6	15.2
May	17.7	16.5	19.3	16.8	17.8
June	22.4	24.1	22.7	22.2	24.6
July	24.6	25.9	25.6	26.4	26.9
August	24.4	24.5	27.9	23.5	25.1
September	20.1	19.8	21.4	21.6	21.8
October	15.3	17.1	14.7	12.9	18.5
November	10.4	10.0	15.5	10.9	12.7
December	13.0	9.8	9.5	9.3	7.6
Means	15.3	13.8	16.3	12.9	15.34
Total	183.1	165.6	195.1	154.1	184.1

Table 2. Long-term average monthly and annual rainfall (mm) for the experimental site in Bursa Province.

Month	1970-2011	2009	2010	2011	2012
January	79.4	116.6	149.7	72.4	121.2
February	71.0	156.6	178.9	18.4	123.5
March	66.8	121.1	115.3	67.4	89.6
April	65.9	26.9	36.4	76.8	100
May	44.2	0.0	29.4	27.3	80.6
June	34.1	9.2	135.2	14.0	3.6
July	17.4	4.4	25.0	5.2	7.0
August	16.9	0.0	5.2	29.3	1.8
September	40.9	67.4	52.9	32.8	16.6
October	76.2	37.9	396.6	112.8	34.6
November	81.3	80.6	24	-	53.3
December	101.4	119.1	152.6	-	178.5
Means	57.9	61.7	108.4	45.7	67.52
Total	695.5	739.8	1301.2	456.4	810

of the study were lower than the long-term average and amounted to 13.8 and 12.9°C, respectively, whereas the average temperature during the second year was slightly higher (16.3°C) (Table 1).

In 2009, the average monthly rainfall was 61.7 mm, whereas the average monthly rainfalls for the second and third years of the study were 108.4 mm and 45.7 mm, respectively. The long-term average monthly rainfall for Bursa Province is 57.9 mm. During the first two years of the study, the average rainfall on a monthly basis exceeded the long-term average.

During the third year of the study, the average rainfall on monthly basis was less than the long-term average. In 2010, the average rainfall was markedly higher than the long-term average and also higher than that in 2009 and 2011 (Table 2).

More than half of the experimental fields have dense soils in the medium alkaline pH group, as classified in term of their density and pH.

In terms of organic matter content, the soils of experimental fields were poor in humus but the available potassium, calcium, and magnesium content was relatively high (Deveciler, 2005).

RESULTS AND DISCUSSION

The grain yield per decare for the studied genotypes are given in Table 3. Analysis of variance showed significant genotype x environment interaction. Values of the regression coefficient (b) and deviation from regression (S²d) are given in Table 4.

The means of grain yield for the lines and cultivars changed significantly from year to year (Table 3). The highest average grain yields was noted for Pehlivan in 2009-2010 (412.5 kg da^{-1}), Gx22-1 in 2010-2011 (566 kg da^{-1}), and for 22-1xK in 2011-2012 (478.5 kg da^{-1}).

The lowest grain yield was found for Kx15-4 in 2009-2010 (173.1 kg $da^{-1)}$, for Gonen in 2010-2011 (320.7 kg da^{-1}) and for Flamura in 2011-2012 (244.3 kg da^{-1}).

The three-year means of grain yield per decare for the studied genotypes ranged from 317.8 to 443.0 kg da^{-1}. The values for GxK-3 and Pehlivan were high according to the three year means. Lines (Kx15-4)-2, (15-4x22-1)-4 and (GxK) were outstanding, showing a high grain yield per decare during both the second and the third years of the study (Table 3).

The many adaptation and stability parameters that have been developed present contradictions for plant breeders they need

Table 3. Average grain yields (kg da^{-1}) of wheat lines and cultivars examined in three years.[a]

	Grain Yield (kg da^{-1})			
Genotype	2009-2010	2010-2011	2011-2012	mean
(SBxK)-1	309.0 c-e	326.3 jk	357.0 de	330.8 bc
(SBxK)-2	376.1 ab	362.7 i-k	361.6 de	366.8 a-c
(SBx15-4)-1	213.2 j-m	422.7 d-i	377.7 c-e	337.9 bc
(SBx15-4)-3	342.3 b-d	369.3 h-k	350.6 de	354.1 a-c
(SBx15-4)-5	177.2 m	434.0 c-i	410.5 a-d	340.6 bc
(Kx15-4)-1	182.6 lm	465.0 b-g	440.9 a-c	362.8 a-c
(Kx15-4)-2	173.1 m	498.7 a-d	434.1 a-c	368.6 a-c
(A-12x15-4)-4	241.2 g-l	476.7 b-f	465.1 ab	394.3 a-c
(Gx22-1)-2	305.4 d-f	464.0 b-g	405.1 b-d	391.5 a-c
(Gx22-1)-4	298.1 d-g	446.7 c-h	409.1 a-d	384.6 a-c
(Gx22-1)-6	276.4 e-h	423.0 d-i	383.4 c-e	360.9 a-c
(Gx22-1)-7	215.2 ı-m	421.7 d-i	383.8 c-e	340.5 bc
(GxK)-2	209.6 k-m	431.0 c-i	328.9 e	323.1 c
(GxK)-3	404.4 a	491.3 a-e	433.3 a-c	443.0 a
(15-4x22-1)-4	203.9k-m	561.0 a	388.7 ab	384.5 a-c
(KxG)	218.8 h-m	535.0 ab	388.7 c-e	380.8 a-c
(SBxK)	304.2 d-f	510.7 a-c	383.8 c-e	399.6 a-c
(22-1xK)	227.2 h-m	383.3 g-k	478.5 a	363.0 a-c
(A-12xK)	275.5 e-ı	408.7 e-j	436.1 a-c	373.4 a-c
(G x K)	292.1 d-g	487.3 a-e	435.6 a-c	405.0 a-c
(GxSB)	325.7 b-e	443.3 c-i	397.0 b-e	388.7 a-c
(Gx22-1)	271.0 e-j	566.0 a	383.9 c-e	407.0 a-c
Gonen	248.1 f-k	320.7 k	384.8 c-e	317.8 c
Pehlivan	412.5 a	394.7 f-k	465.8 ab	424.3 ab
Flamura	368.5a-c	390.5 g-k	244.3 f	334.4 bc
$LSD_{0.05}$	60.7	83.3	70.71	93.9
Mean	274.8	441.4	397.13	371.1

[a] Values followed by the same letter are not significantly different at P= 0.05.

to know which parameters should be considered for the different target regions. Recently, the top approach among considereable alternatives for plant breeders is to choose genotypes based on the criteria of high grain yield potentials and stability. Lately, there have been many investigations into the relationships between parameters that consider how environmental adaptation abilities and stability features vary with different stability parameters in wheat genotypes (Amin *et al.,* 2005; Özcan *et al.,* 2005; Ülker *et al.,* 2006; Khan *et al.,* 2007; Arain *et al.,* 2011; Hamlabad 2012, Mohammadi *et al.,* 2012; Mohtasham *et al.,* 2012).

Stability analysis is often used in multi-location trials, but it can also be applied to measure the response of cultivars in the same location to changes occurring in different years. This investigation aimed to define environmental adaptation and stability features and the relationships between stability parameters using 25 bread wheat genotypes that were grown in the ecological conditions of Bursa City over 3 years. Using the same approach, Akçura *et al*. (2007) tested 11 bread wheat cultivars over 6 years in Kahramanmaras and used different stability parameters to study adaptation of cultivars to varoius environmental conditions. Similarly Kahrıman *et al*. (2010) carried out yield trials with wheat in Çanakkale during four

years with the aim of determining the utility of different statistical methods for selection of varieties. The results of these two studies suggest that the stability statistics used here vary for their effectiveness in choosing varieties, and not all of the methods point out the same genotypes when determining the stability levels.

In breeding, it is of interest to study and determine adaptation and stability parameters in conjunction with the increase in average yield (Yagdi, 2002). In general, genotypes with high yield, regression coefficient (b_i) close to 1, and non-significant deviation from the regression line are considered as the most desirable (Eberhart and Russell, 1966; Becker and Leon, 1988; Ketata, 1990).

Value of regression coefficient less than 1 indicates that the plant can adapt to poor environmental conditions, whereas a *bi* value greater than 1 indicates that the plant can adapt to favourable environmental conditions (Yildirim *et al*., 1979, Akgun and Altındag, 2011).

The regression coefficients determined in this study ranged from -0.114 to 2.009. According to these values, the lines of (SBx15-4)-1, (Gx22-1)-2, (Gx22-1)-4, (Gx22-1)-6 and (GxK) showed a good stability (Table 4).

Figure 1, based on the methods of Finlay and Wilkinson (1963), shows that ten lines: (SBx15-4)-1 (no 3), (Gx22-1)-2 (no 9), (Gx22-1)-4 (no 10), (Gx22-1)-6 (no 11), (Gx22-1)-7 (no 12), (GxK)-2 (no 13), (SBxK) (no 17), (22-1xK) (no 18), (A-12xK) (no 19) and (GxK) (no 20) can adapt well to all environmental conditions even if the conditions improve or worsen. It is further understood that their yields remain stable. Additionally, because the means of yield values for the lines (Gx22-1)-2, (Gx22-1)-4, (SBxK), (A-12xK) and (GxK) exceeded the overall average, grain yield of these lines is expected to increase if the conditions improve and to remain stable if the conditions deteriorate.

Some other tested lines were able to adapt to favourable conditions, and their yields were stable only under favourable conditions. Four of these lines i.e. (A-12x15-4)-4, (15-4x22-1)-4, (KxG), and (Gx22-1) were able to adapt well to favourable conditions, and their yields are expected to increase as the conditions improve.

Additionally, (SBxK)-1, (SBxK)-2, (SBx15-4)-3, (GxK)-3, (GxSB), Gonen, Pehlivan and Flamura did not remain stable under favorable or unfavorable conditions. Although Gonen, Pehlivan and Flamura are commonly used in Turkey, they were unable to remain stable in terms of yield value during the years of the study.

Table 4. Means, regression coefficients (b) and deviation mean squares for grain yield for each genotype.

Number of lines	Lines	Means (x)	Regression coefficients (b)	Deviation mean squares (S²d)
1	(SBxK)-1	330.8 bc	0.16	770.953
2	(SBxK)-2	366.8 a-c	-0.089	13.543
3	(SBx15-4)-1	337.8 bc	1.276	70.247
4	(SBx15-4)-3	354.1 a-c	0.142	83.076
5	(SBx15-4)-5	340.6 bc	1.620	1239.44
6	(Kx15-4)-1	362.8 a-c	1.785	1605.12
7	(Kx15-4)-2	368.6 a-c	1.993	296.589
8	(A-12x15-4)-4	394.3 a-c	1.503	1611.11
9	(Gx22-1)-2	391.5 a-c	0.923	174.837
10	(Gx22-1)-4	384.6 a-c	0.896	2.242
11	(Gx22-1)-6	360.9 a-c	0.879	0.271
12	(Gx22-1)-7	340.5 bc	1.271	199.659
13	(GxK)-2	323.1 c	1.256	1162.019
14	(GxK)-3	443.0 a	0.461	761.026
15	(15-4x22-1)-4	384.5 a-c	2.009*	3731.69
16	(KxG)	380.8 a-c	1.789	2418.22
17	(SBxK)	399.6 a-c	1.114*	3227.009
18	(22-1xK)	363.0 a-c	1.177**	11586.383
19	(A-12xK)	373.4 a-c	0.910	2449.903
20	(G x K)	405.0 a-c	1.173	0.004
21	(GxSB)	388.7 a-c	0.680	141.367
22	(Gx22-1)	407.0 a-c	1.590**	6699.109
23	Gonen	317. c	0.582*	4314.515
24	Pehlivan	424.31 ab	0.009*	2735.632
25	Flamura	334.4 bc	-0.114**	12225.973
	$LSD_{0.05}$	93.9		
	Mean	371.8		

* Significant at P= 0.05, ** Significant at P= 0.01.

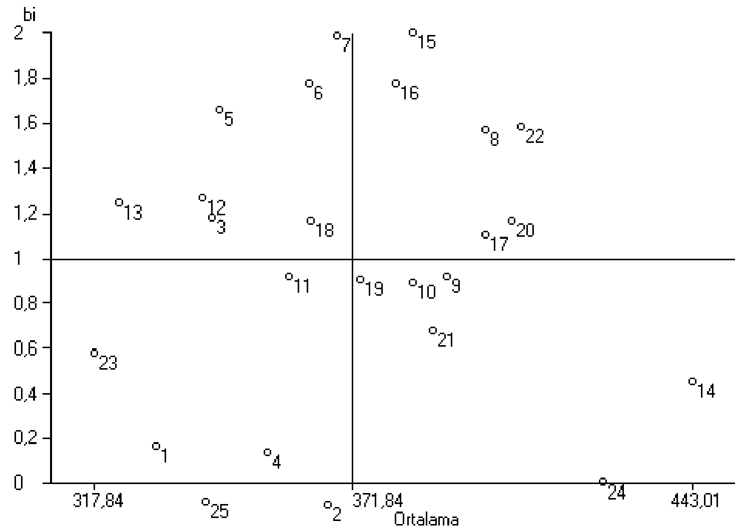

Figure 1. Graphs of regression coefficients and grain yields for wheat lines and varieties.
1: (SBxK)-1; 2: (SBxK)-2; 3: (SBx15-4)-1; 4: (SBx15-4)-3; 5: (SBx15-4)-5; 6: (Kx15-4)-1; 7: (Kx15-4)-2; 8: (A-12x15-4)-4; 9: (Gx22-1)-2; 10: (Gx22-1)-4; 11: (Gx22-1)-6; 12: (Gx22-1)-7; 13: (GxK)-2; 14: (GxK)-3; 15: (15-4x22-1)-4; 16: (KxG); 17: (SBxK); 18: (22-1xK); 19: (A-12xK); 20: (G x K); 21: (GxSB); 22: (Gx22-1); 23: Gonen; 24: Pehlivan, and 25: Flamura.

The value for the deviation from the regression line serves as another stability parameter. For stable genotypes, this value should be low and close to zero (Eberhart and Russell, 1966; Yagdi, 2002; Amin *et al*., 2005; Aycicek and Yildirim, 2006; Hassan *et al*., 2013). In the present study, the lines with the greatest stability according to this criterion were (GxK), (Gx22-1)-6, and (Gx22-1)-4, all with values very close to 0 (Table 5).

In view of the stability and adaptation parameters values determined in this study, it can be concluded that the adaptation ability of the lines (Gx22-1)-4, (Gx22-1)-6 and (GxK) is relatively higher and they are more stable than the other genotypes.

ACKNOWLEDGEMENTS

The authors wish to thank American Journal Experts for editing and English proofreading of the manuscript. The authors also thank Uludag University for editing and English proofreading service support.

REFERENCES

1. Akcura M., Kara, R., Akaya, A., Dokuyucu, T. and Kıllı, F. 2007. Parametric and Non-Parametic Stability Analyses for Grain Yield of Bread Wheat (*Triticum aestivum* L) Genotypes in Kahramanmaraş Conditions of Turkey. *Turkish J. Field Crop.,* **12(1):** 8-20.
2. Amin, M. T., Mohammad, A. J. K., Irfaq, M. A. and Tahir, G. R. 2005. Yield Stability of Spring Wheat (*Triticium aestivum L.*) in the North West Frontier Province. *Pak. Sonklanakarin J. Sci. Technol.,* **27(6)**: 1147-1150.
3. Anonymous. 2010. *Climate Data for the Region of Bursa*. Department of Water Affairs and Forestry, General Directorate of Meteorology, Bursa, Turkey.
4. Akgun, I. and Altindag, D. 2011. Stability Analysis and Grain Yield in Some Triticale Genotypes. *Suleyman Demirel Univ. J. Faculty Agric.,* **6(1)**: 7-14.
5. Altay, F. 2012. Yield Stability of Some Turkish Winter Wheat (*Triticum aestivum* L.) genotypes in the western transitional zone of Turkey. *Turkish J. Field Crop.,* **17(2)**: 129-134.
6. Arain, M. A., Sial, M. A., Rajput, M. A. and Mirbahar, A. A. 2011. Yield Stability in Bread Wheat Genotypes. *Pak. J. Bot*., **43(4):** 2071-2074.
7. Aycicek, M. and Yildirim, T. 2006. Adaptability Performances of Some Bread Wheat (*Triticum aestivum L.*) Genotypes in the Eastern Region of Turkey. *Int. J. Sci. Tech*., **1(2)**: 83 89.
8. Becker, H. C. and Leon, J. 1988. Stability Analysis in Plant Breeding. *Plant Breed.,* **101**: 1-23.
9. Deveciler, H. 2005. A study on Heavy Metal Contents in the Soils of Applied Research Centre for Agriculture of Uludag Universty. Master's Thesis, UU Institute of Science.
10. Eberhart, S. A. and Russell, W. A. 1966. Stability Parameters for Comparing Varieties. *Crop. Sci*., **6**:36-40.
11. Finlay, K. W. and Wilkinson, G. N. 1963. The Analysis of Adaptation in a Plant Breeding Programme. *Aust. J. Agric. Res.,* **14**: 742-754.
12. Francis, T. R. and Kannenberg, W. 1978. Yield Stability Studies in Short Season Maize. *Can. J. Plant Sci.*, **58:** 1029-1034.
13. Hamlabad, H. 2012. Yield Stability of Promising Lines of Winter and Facultative Wheat in Different Climate of Iran. *African J. Agric. Res.*, **7(15):** 2304-2311.
14. Hassan, M. S., Mohamed, G. I. A. and El-Said, R. A. R. 2013. Stability Analysis for Grain Yield and It's Components of Some Durum Wheat Genotypes (*Triticum durum* L.) under Different Environment. *Asian J. Crop Sci.*, **5(2):** 179-189.
15. Huehn, M. 1990. Nonparametric Estimation and Testing of Genotype×Environment Interactions by Ranks, Genotype-by-environment Interaction and Plant Breeding. Louisiana State University, Baton Rouge, PP. 69-93.
16. Kahriman, F., Egesel, C. O., Baytekin, H. and Gul, M. K. 2010. Use of Parametric and Nonparametric Stability Statistics. *YYU J. Agr. Sci.,* **20(1):** 32-40.
17. Ketata, H. 1990. Genotype-environment Interaction (Unpublished). Biometrical Genetics for Cereal Breeders. 14-22 February, ICARDA, Syria.
18. Khan, A. J., Faroog-i Azam, A. A. and Tarig, M. 2007. Grain Yield Stability Analysis of Wheat (*Triticum aestivum* L.) Genotypes from

NWFP of Pakistan. *Pak. J. Agric. Res.,* **20**: 3-4.
19. Mohammadi, M., Karimizadeh, R., Hooseinpou, T., Falahi, H. A., Khanzadeh, H., Sabaghnia, N., Mohammadi, P., Armion, M. and Hosni, M. H. 2012. Genotype× Environment Interaction and Stability Analysis of Seed Yield of Durum Wheat Genotypes in Dryland Conditions. *Not. Sci. Biol.,* **4(3):** 57-64.
20. Mohtasham, M., Karimizadeh, R., Sabaghnia, N. and Shefazadeh, M. K. 2012. Genotype×Environment Interaction and Yield Stability Analysis of New Improved Bread Wheat Genotypes. *Turkish J. Field Crop.,* **17(1):** 67-73.
21. Özcan, H., Aydın, N. and Bayramoglu, H. O. 2002. Ekmeklik Buğdayda Verim Stabilitesi ve Stabilite Parametreleri Arasındaki Korelasyon. *Tarım Bilimleri Dergisi,* **11(1):** 21-25.
22. Sahin, M., Aydogan, S. and Akcacik, A. G. 2006. A Research on Determination of Stability of Yield and Quality of Some Bread Wheat Varieties under Rain-fed Konya Ecological Conditions. *J. Crop Res.,* **1(16)**: 16-22.
23. Shukla, G. K. 1972. Some Statistical Aspects of Partitioning Genotype-environmental Components of Variability. *Hered.,* **29**: 237-245.
24. Turan, Z. M. 1995. Research and Trial Methods. *UU. Agr. Faculty Study Paper,* **62**: 121.
25. Ülker, M., Sönmez, F., Çiftçi, V., Yılmaz, N. And Apak, R. 2006. Adaptatıon and Stability Analysis in the Selected Lines of Tir Wheat. *Pak. J. Bot.,* **38(4)**: 1177-1183.
26. Yagdi, K. 1998. Determination of Enviromental Adaptation and Stabilites of Some Hard Wheat Strains (*Triticum durum* Desf.). *J. Agric. Faculty Uludag Univ.*, **14**: 85-92.
27. Yagdi, K. 2002. A Research on Determination of Stability Parameters of Bread Wheat (*Triticum aestivum* L.) Cultivars and Lines Grown in Bursa Province. *J. Agric. Faculty Uludag Univ.*, **16:** 51-57.
28. Yates, F. and Cochran, W. G. 1938. The Analysis Groups of Experiments. *J. Agric. Sci.,* **28**: 556-580.
29. Yıldırım, M. B., Öztürk, A., İkiz, F. and Püskülcü, H. 1979. Bitki Islahında İstatistik-Genetik Yöntemler. *Ege Bölge Zirai Araştırma Ens. Yayınları*, **20**: 217-251.
30. Wricke, G. 1962. Über eine Methode zur Erfassung der Ökologischen Streubreite in Feldversuchen. *Z Pfl-Zücht,* **47**: 92-96.

پایداری عملکرد رگه های گندم نان (*Triticum aestivum* L.)

پ. ا. کرد پولات، ا. ا. کیفکی، و ک. یاقدی

چکیده

هدف اصلی بهنژادی گیاهان بهبود پایداری و ثبات عملکرد آنها و به دست آوردن رقم هایی است که از کیفیت بالایی برخوردار باشند. به این منظور، پژوهشی روی رقم های گندم در سال های۱۲-۲۰۱۰ در مرکز کاربرد و تحقیقات کشاورزی در دانشکده کشاورزی دانشگاه Uludagدر منطقه بورسا در ترکیه اجرا شد. در این پژوهش، ۲۲ رگه پیشرفته گندم نان و سه کولتیوار شاهد به نام های Pehlivan ،Gonen، و Flamuraدر یک آزمایش سه ساله بررسی شدند. در هر سال، آزمایش در یک طرح بلوک های تصادفی با سه تکرار اجرا شد و در آن اثر های کولتیوار، محیط، و برهمکنش ژنوتیپXمحیط مورد ارزیابی قرار گرفت. بر اساس نتایج آزمایش توانستیم سه رگه را به نام های 4-(Gx22-1)، 6-(Gx22-1)، و (GxK)شناسایی کنیم که از ژنوتیپ های دیگر دارای سازگاری و ثبات عملکرد بیشتری بودند.