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# THE RESPONSE OF BREAD WHEAT GENOTYPES IN DIFFERENT DROUGHT TYPESI. GRAIN YIELD, DROUHGT TOLERANCE AND GRAIN YIELD STABILITY

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**ABSTRACT**

**The purpose of this study was to determine bread wheat genotypes with high yield potential and stability under controlled field conditions which resembled drought types exist in different plant growth stages in the Central Anatolia Region.This study was conducted using split-plot arrangement in randomized complete block design with four replications, the main plots were five drought treatments (D1: the general drought that represents the long term drought in region, D2:drought from the initiation of stem elongation to the initiation of heading stage, D3:drought from the initiation of heading to the end of flowering stage, D4:drought during grain filling period, D5: full irrigation) and ten bread wheat genotypes (Karahan 99, Bayraktar 2000, Gerek 79, Dagdaş 94, Bezostaja 1, Goksu 99, Konya 2002, BDME 09/1 K, BDME 09/2 K and 08-09 KEBVD 24) were the subplots under rain shelter in 2009-2010 and 2010-2011 plant growing seasons in Konya. The yield responses of bread wheat genotypes to drought stress were evaluated by drought susceptibility index (DSİ) and yield stability parameters.The results showed that grain yield values varied from 5771 (D3) to 8111 kgha$^{-1}$(D5) by drought treatments, and from 5686 (Goksu 99) to 7552 kgha$^{-1}$ (Konya 2002) among genotypes. The grain yields of genotypes under D1, D2, D3 and D4 treatments compared to decreased 15.3, 16.6, 28.8 and 23.7 % respectively. DSI values ranged between 0.674 (Dagdas 94) – 1.919 (Goksu 99). BDME 09/1K and BDME 09/2K were varieties with wide adaptation and stability while Goksu 99 had the lowest grain yield levels in all drought stress conditions.**

**Key words: Drought, drought susceptibility index, yield stability, wheat**

## INTRODUCTION

Drought is one ofthe most important environmental stress factors limited the plant production ina great part of rainfed areas in the world and Turkey.Agreat proportion(80%)of the wheat produced in Turkey is being grownunderrainfed areas.A great part of this takes from the Central Anatolia and Transition Regions.On top of factors affected the yield in these areascomes inadequate rainfall and the distribution unbalanced of rainfall in plant growing period (Sade, 2008).These conditions, as depended to the intensity and distribution of drought, can be cause to the loss of yield reached to 40-65% (Ozturk, 1999).

The better understanding how and to what extent drought in different plant growth stages affects the yield of wheat,will be able tohelp toprovide advances in the improvement of genotypes had high yield and adaptation capability,according to a region described ecological conditions and the type of dominating drought. Therefore, the evaluation by drought susceptibility index (DSI) developed by using its performance loss in dry conditions according to the potential yields ofbread wheat genotypesis widely used at classification in terms of drought resistance of genotypes (Fischer and Maurer, 1978; Clark et al., 1984; Bruckner et al., 1987).Furthermore, the use of methods of yield stability for the determination of the adaptation to diverse environmental conditions of bread wheat genotypes were startedby Yates and Cochran (1938) and then, were continued by Finlay and Wilkinson (1963) and Eberhart and Russell (1966).

In this research, it was purposed that bread wheat genotypes which combined high grain yield potential and stability were determined, evaluating the yield responses of wheat genotypes under controlled field conditions which resembled drought types exist in different plant growth stages in the Central Anatolia Region.

## MATERIALS AND METHODS

This research was conducted in BahrıDagdas International Agricultural Research Institute (BDIARI) during 2009-2010 and 2010-2011growing seasons.As plant materials were used totally ten bread wheat genotypes that comprised seven registered varieties (Karahan 99, Bayraktar 2000, Gerek 79, Dagdas 94,

Bezostaja 1, Goksu 99, Konya 2002), two advanced lines(BDME 09/1 K, BDME 09/2 K)which improved for dry conditions in bread wheat breeding program in BDIARI and one landraces (08-09 KEBVD 24).

The experiment was laid out as split-plot design in randomized complete block design with four replicates with drought and supplementalwater applications as main plots and genotypes as subplots.In the experiment, each plotconsisted of 4 rows, 1.5 m long and spaced 20cm apart. Ten genotypes located in subplots were distributedto the replications depending chance.Drought and supplemental water applications determined as main treatments were applied in five different levels.

*Applications:*Plant growing stages were determined according to Zadoks Scale (ZS). In experiment, genotypes grown in the field conditions in 1st, 2nd, 3rd and 4th main plots were exposed to natural conditionsuntil the initiation of stem elongation (ZS 30).Starting from these stages,it was covered withthe rain-sheltersuntil the end ofgrain fillingperiod, and in this way, it was prevented from precipitation.

*Drought (D) 1*

Control;to testthe general drought that represents the long term drought in the region, starting from the initiation of stem elongation (ZS 30), the plots were irrigated by drip irrigation at parallel levels to the average rainfall of long-term (35 mm in period of ZS 30, 50 mm in period of ZS 50, 25 mm in period of ZS 70) in each plant development stages.

*D2*

The initiation of stem elongation – the initiation of heading stage (ZS 30-50);to test the earlyspringdrought in the region, these plotswere exposed todrought.At following periods,50 mm in period of ZS 50-70 and 25 mm in period of ZS 70-94, it was irrigated by drip irrigation at parallel levels to the average rainfall of long-term.

*D3*

The initiation of heading – the finally of flowering stage (ZS 50-70);to test the generative-term droughtin the region, these plotswere exposed todrought. At the otherstages ofplantdevelopment, 35 mm in period of ZS 30-50 and 25 mm in period of ZS 70-94, it was irrigated by drip irrigation at parallel levels to the average rainfall of long-term.

*D4*

Grain filling period (ZS 70-94);to test the drought inthe lateperiod in the region, these plotswere exposed todrought. At the otherstages ofplantdevelopment, 35 mm in period of ZS 30-50 and 50 mm in period of ZS 50-70, it was irrigated by drip irrigation at parallel levels to the average rainfall of long-term.

*D5*

Full irrigation; to determinatethe yield potential of the genotypes, and to evaluate as a control in determination of the response across drought of bread wheat genotypes located in drought applications,these plotswere irrigated by drip irrigationas 35 mm in period of ZS 30-50, 50 mm in period of ZS 50-70 and 25 mm in period of ZS 70-94. In addition, it was not taken under the rain shelter, and itwas provided that genotypes take precipitation.

The applicationsof artificialdrought that created in different plant development stages,using the polyethylene parcel covers (in thickness 0.25 mm and 95% of the photosynthetic light can pass), were provided by rain shelters with fixed position.The rain shelters were placed in height 1.5 m from soil level around the edges and in shape wellover around 2 m from the edges of plots (Ozturk, 1999).All plots were insulated withadditionalplots that was not applied the irrigation and the rain shelters to avoidfrom the effects ofother applications.In addition, the rain water flown from the coversin plots used the rain shelter was removed by the drainage channels from the plots.The irrigation practices in trials were applied by the drip irrigation method to the main plots. The amount of water to be applied was given by measuring by a sensitive water meter which was mounted to the secondary water pipe at the beginning of each main plot.

Until it was covered the rain shelters from the sowing of genotypes, in drought applications (D1, D2, D3 and D4), it was taken 266 mm and 346 mm rainfall, respectively, according to the product years.InD5,amount of rainfallreceived by the endof thegrain filling periodwas347.8and437.0mm.In the measurements which taken by thermo-hygrograph device, it was determined that relative humidity and temperature of the air didn't change according to normal air conditions in plots applied the drought.

Trial was established after the fallow into fallow - wheat rotation system. In the third week of October, the plots were prepared in accordance to the trial plan. Each genotype was sown by hand at the rate of 550 seed$m^{-2}$, spaced 20cm apart, at a depth of5-6cm to drawingdrop-downwithspringharrow.At each main plot, fertilization was applied as 23.5 kg $ha^{-1}$ nitrogen and 60 kg$ha^{-1}$ phosphorus at sowing time and 46.5 kg $ha^{-1}$ nitrogen at jointing stage. Weed control was achieved by applying chemical pesticides and was plucked by hand from time to time.When it comes to harvest the plants in the plots, it was cut by a sickle and was grained by the combine harvester.

In this study,the followingobservations andmeasurements were made.

*Grain yield*

The grain product obtained from each of the plots was expressed as kg $ha^{-1}$ by weighting at 0.01 g precise scale (Kalayci et al., 1998).

*Drought susceptibility index*

The value obtained from the application taken of the highest yield for each genotype, it has been considered as the potential of genotype in that environment, by comparing with these potentials the yields of application plots,for each genotype were calculated using the following formula (Fischer and Maurer, 1978).

Drought Intensity (DI) = (MYp - MYs) / MYp

MYp: Mean yield over all genotypes evaluated under non-stress conditions

MYs: Mean yield over all genotypes evaluated under stress conditions

Drought Susceptibility Index (DSI) = [(Yp – Ys) / Yp] / DI

Yp: Yield under non-stress conditions

Ys: Yield under the stress conditions

DI: Drought intensity

*Grain YieldStability:* Linear regressionmethod was used(Eberhart and Russell, 1966).

*Climate andSoilProperties of Trial Location*

The average monthly values during 2009-2010 and 2010-2011 growing seasons of some climatic elements were given in Table 1.

**Table 1**. The long-term average of some climatic elements and monthly averages for the test year in Konya

| | Months | Sep. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **L. T. A.**** | Avg.T. ($^0$C)* | 18,7 | 12,6 | 5,9 | 1,5 | -0,3 | 1,0 | 5,7 | 11,1 | 15,8 | 20,4 | 23,6 | 23,2 | 11,6 |
| | Max. T.($^0$C) | 36,1 | 31,6 | 25,2 | 20,0 | 17,6 | 21,2 | 28,9 | 31,5 | 33,4 | 37,2 | 40,6 | 37,8 | 40,6 |
| | Min. T.($^0$C) | 1,2 | -7,6 | -20,0 | -22,4 | -25,8 | -25,0 | -15,8 | -8,6 | -1,2 | 3,2 | 7,5 | 7,5 | -25,8 |
| | Rainfall (mm) | 11,6 | 32,2 | 37,6 | 41,9 | 34,4 | 24,4 | 26,2 | 38,8 | 41,7 | 20,1 | 7,5 | 5,0 | 321,4 |
| | R. Hum. (%) | 46,0 | 58,0 | 69,0 | 77,0 | 76,0 | 70,0 | 62,0 | 58,0 | 55,0 | 47,0 | 42,0 | 42,0 | 58,5 |
| **2009-2010** | Avg. T. ($^0$C) | 16,8 | 14,3 | 5,6 | 4,3 | 2,5 | 5,4 | 7,9 | 10,4 | 16,3 | 19,7 | 24,7 | 25,9 | 12,8 |
| | Max. T. ($^0$C) | 30,6 | 28,3 | 19,2 | 17,0 | 17,2 | 20,0 | 23,7 | 22,5 | 30,2 | 31,3 | 37,4 | 38,4 | 38,4 |
| | Min. T. ($^0$C) | -0,4 | 2,0 | -6,0 | -7,2 | -12,0 | -9,2 | -7,5 | -1,7 | 2,1 | 6,7 | 9,2 | 13,2 | -12,0 |
| | Rainfall (mm) | 22,2 | 14,4 | 60,6 | 72,4 | 43,4 | 33,0 | 14,6 | 27,6 | 13,6 | 76,2 | 7,4 | 0,0 | 385,4 |
| | R. Hum. (%) | 51,8 | 54,7 | 82,6 | 87,9 | 85,2 | 74,1 | 60,8 | 64,7 | 50,0 | 57,4 | 40,6 | 32,0 | 61,8 |
| **2010-2011** | Avg. T. ($^0$C) | 20,4 | 12,0 | 8,9 | 4,6 | 1,1 | 1,7 | 4,6 | 8,8 | 13,2 | 18,4 | 24,3 | 22,3 | 11,7 |
| | Max. T. ($^0$C) | 32,4 | 26,3 | 22,5 | 19,7 | 17,2 | 20,0 | 23,7 | 22,2 | 30,2 | 31,7 | 37,4 | 38,4 | 38,4 |
| | Min. T. ($^0$C) | 7,3 | -0,7 | -2,4 | -5,0 | -11,9 | -9,2 | -7,5 | -1,4 | 2,1 | 6,6 | 9,2 | 11,2 | -11,9 |
| | Rainfall (mm) | 8,6 | 71,8 | 2,4 | 71,2 | 46,5 | 52,2 | 35,4 | 67,1 | 64,0 | 62,6 | 4,0 | 3,6 | 489,4 |
| | R. Hum. (%) | 42,2 | 74,1 | 66,1 | 85,1 | 90,1 | 82,3 | 78,3 | 76,2 | 73,7 | 60,2 | 39,6 | 40,4 | 67,3 |

*Avg. T.: Average Temperature, Max. T.: Maximum Temperature, Min. T.: Minimum Temperature,
R. Hum: Relative Humidity
**L. T. A. (Long-Term Average): Average values for the period 1975-2008 (DMI)

It has been the annual total rainfall 385.4 and 489.4 mm, respectively, compared to the product years.Especially in the second year, the sum rainfall of both products year was well above the long term average rainfall (321.4 mm).That the average temperature (12.8 $^o$C) in the first product year was over the long term average temperature, it was accelerated the maturing period.

According to analyzes done on soil samples taken from the depths 0-30 cm and 30-60 cm of trial soils, it was determined that texture class was a clay-loam type, that the organic material content was at middle levels (1.2-2.53%), that calcium content was high (29.48-33.16 %),that the convenient phosphor amount was an adequate level (69.9-110.6 kgha$^{-1}$),in terms of potassium was rich (621.7-888.9 kg $ha^{-1}$) and that the soil had the alkaline reaction (pH: 8.30).

In the evaluated of data obtained from trials, it was applied the variance analyzes, and was grouped according to the LSD (5%) test mean. To analyze the data was used JMP 5.0.1statistical software.

## RESULTS AND DISCUSSION

*Grain Yield*

The analysis of variance for grain yield of bread wheat genotypes determined in different drought applications were presented in Table 2. Also, the grain yield values and the groups of significance were given in Table 3. The year in terms of grain yield, drought applications and the difference among genotypes, and difference between the year x drought interaction, year x genotype interactionand drought x genotype interaction were statistically significant ($p < 0.01$).Accordingly, there were large differences among the years, drought applications and the genotype means. Also, differences among the performances of genotypes have varied from treatment to treatment and from year to year.The analysis of variance for grain yield of bread wheat genotypes tested in 10 environments (two years and five different drought treatments) showed that 60,1% of the total sum of squares was attributable to environment effects (year 6,2 %, drought 53,9 %), only 27,3% to genotypic effect and 6,3%

to year x genotype interaction and 6,4% drought x genotype interaction effects (Table 2).

**Table 2.** The analysis of variance for grain yield of bread wheat genotypes determined in different drought applications

| Source of variation | d.f. | Sum of squares | Mean squares | (%) GxE Explained |
|---|---|---|---|---|
| Year (Y) | 1 | 287418,00 | 287418** | 6,2 |
| Replication [Year] | 6 | 12860,10 | 2143,35 | |
| Drought Treatments (D) | 4 | 2513276,00 | 628319** | 53,9 |
| Y*D int. | 4 | 92811,20 | 23202,8** | |
| Error (1) | 24 | 101728,00 | 4238,65 | |
| Genotype (G) | 9 | 1272300,00 | 141367** | 27,3 |
| Y*G int. | 9 | 291774,00 | 32419,4** | 6,3 |
| D*G int. | 36 | 297535,00 | 8264,85** | 6,4 |
| Y*D*G int. | 36 | 95828,30 | 2661,90 | |
| Error (2) | 270 | 945228,80 | 3500,80 | |
| Genel | 399 | 5910758,20 | | |

* ($p<0.05$), ** ($p<0.01$), CV (%): 8,7

**Table 3**. The grain yields of bread wheat genotypes determined in different drought applications (kg ha$^{-1}$)

| Year | Genotypes | Drought applications* | | | | | | | | | | Genotype Avg. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | D 1 | | D 2 | | D 3 | | D 4 | | D 5 | | | |
| 2010-11 Avg. | Karahan 99 | 7109 | k-p** | 6899 | k-r | 6075 | u-y | 6461 | q-w | 8826 | ab | 7074 | c |
| | Bayraktar 2000 | 7042 | k-q | 7128 | j-o | 5768 | x-z | 6423 | r-w | 7904 | d-h | 6853 | cd |
| | Gerek 79 | 6872 | k-r | 6848 | l-s | 5652 | yz | 6055 | u-y | 7695 | f-j | 6625 | de |
| | Dağdaş 94 | 6735 | m-t | 6468 | q-w | 5465 | z | 6018 | v-z | 7256 | ı-m | 6388 | e |
| | Bezostaja 1 | 6259 | t-x | 5978 | w-z | 5157 | z | 5604 | yz | 7037 | k-q | 6007 | f |
| | Göksu 99 | 5291 | z | 5606 | yz | 4509 | z | 4748 | z | 8279 | b-e | 5686 | g |
| | Konya 2002 | 7973 | c-g | 7267 | ı-m | 6497 | q-w | 6917 | k-r | 9106 | a | 7552 | a |
| | BDME 09/1K | 7389 | h-l | 7721 | e-ı | 6278 | s-x | 6619 | n-u | 8524 | bc | 7306 | ab |
| | BDME 09/2K | 7445 | g-k | 7197 | ı-n | 6467 | q-w | 6908 | k-r | 8337 | b-d | 7271 | b |
| | 08-09 KEBVD 24 | 6563 | o-v | 6542 | p-w | 5837 | x-z | 6103 | u-y | 8138 | c-f | 6637 | de |
| Drought Avg. (2010) | | 6759 | cd | 6601 | d | 5599 | f | 5793 | ef | 7608 | b | 6472 | a |
| Drought Avg. (2011) | | 6976 | c | 6929 | c | 5942 | e | 6578 | d | 8613 | a | 7008 | b |
| Drought Avg. (2010-11) | | 6868 | b | 6766 | b | 5771 | d | 6186 | c | 8111 | a | 6740 | |

*D1: the general drought that represents the long term drought, D2: the initiation of stem elongation – the initiation of heading stage, D3: the initiation of heading – the finally of flowering stage, D4: grain filling period, D5: full irrigation

**There is no statistically significant difference among the values shown in the same letters ($P<0.05$). CV (%): 8,7

LSD (0,05) Y: 13,4 LSD (0,05) D: 21,3 LSD (0,05) YxDint.: 30,04 LSD (0,05) G: 26,04LSD (0,05) YxGint: 36,8 LSD (0,05) DxGint.: 58,2 LSD (0,05) YxDxGint.: ns

The overall average grain yield was determined as 6740 kg ha$^{-1}$, this value was in the first year 6472 kg ha$^{-1}$, and in the second year 7008 kg ha$^{-1}$, respectively.In 2010-11 growth periods, favorable climatic conditions before the launch of the drought application (ZD 30), it has been the effective on yield difference between the years.In fact, while the long-term average rainfall was 196 mm until ZD 30 stage, it was 266 mm in the first year of the experiment and 346 mm in the second year, and it has been more 35% and 56%, respectively, than the long-term average rainfall.

In drought applications, the highest grain yield (8111 kg ha$^{-1}$) was obtained from the D5 application.This, the D1 application (6868 kg ha$^{-1}$), the D2 application (6766 kg ha$^{-1}$) and the D4 application (6186 kg ha$^{-1}$) followed.At least grain yield (5771 kg ha$^{-1}$) was obtained from the D3 application.

Compared tofull-irrigation applications, while the highest response to drought was obtained from the D3 application with yield loss 28.8%, it followed by the D4 (23.7%) and D2 (16.6%) applications in order of decreasing, with 15.3% the least response was determined in the D1 application. These results obtained in this study, it is consistent with the findings of research conductedrelated the impact of drought on grain yield in different stages of development (Jamal et al. 1996; Kimurto et al. 2003; Ozturk, 1999).

While the highest average grain yield was obtained from Konya 2002 cultivar with 7552 kg ha$^{-1}$in the bread wheat genotypes,BDME 09/1K, BDME 09/2K, Karahan 99 and Bayraktar 2000 genotypes showed a performance above average overall with yields7306, 7271, 7074, and 6853 kg ha$^{-1}$, respectively.Goksu 99 cultivar had the lowest grain yield (5686 kg ha$^{-1}$).Examined the interactions between genotypes with drought applications,that drought applications showed the different effects on the yield of genotypes,it was observed significant variations ranging from application to application.If genotypes were collectively evaluated with aspects of the response to the different drought stresses,becauseBayraktar 2000, Gerek 79, Dağdaş 94, Bezostaja 1, BDME 09/2K and BDME 09/1K genotypes showed the low yield loss in all drought applications, these genotypes were considered as promising tolerant

genotypes. 08-09 KEBVD 24 local varieties showed a moderate level tolerance to heading and grain filling period drought.Konya2002varietygenerallyexhibiteda moderatedrought tolerance, and it was observed that it was sensitive to early period drought stress.In full-irrigation conditions (D5) were obtained the highest grain yield according to the other applications with 8111 kg $ha^{-1}$.In this application, the grain yield among genotypes was ranged from 7037 kg $ha^{-1}$(Bezostaja 1) to 9106 kg $ha^{-1}$(Konya 2002).Konya 2002 cultivar,obtained the highest grain yield, was followed by Karahan 99, BDME 09/1K and BDME 09/2K genotypes with yields 8826, 8524 and 8337 kg $ha^{-1}$, respectively.In drought stress applications, drought-tolerant BDME 09/1K, BDME 09/2K, Konya 2002 and Karahan 99 genotypes; at the same time, they were come to the fore as the successful genotypes in D5 application representing full-irrigation conditions as well,has been remarkable in terms of the stability of genotypes.

*Drought Susceptibility Index (DSI)*

DSI and the drought Intensity values related grain yield was given in Table 4. That average the drought intensity was determined as 21.1%, in trial, the lowest drought intensity was obtained from the D1 application with 15.3%,and this was followed by D2 and D4 applications with the rates 16.6% and 23.7%, respectively, the highest drought intensity was determined in heading period drought with 28.8%.It is an expression that bread wheat genotypes was the heading stage of development period the most sensitive to drought.

**Table 4**. Drought susceptibility index values and drought intensity related the grain yields of bread wheat genotypes determined in different drought applications

| **Genotipler** | **Drought Susceptibility Index** | | | | **Average** |
|---|---|---|---|---|---|
| | **D1*** | **D2** | **D3** | **D4** | |
| Karahan 99 | 1,26 | 1,31 | 1,08 | 1,12 | 1,19 |
| Bayraktar 2000 | 0,71 | 0,59 | 0,93 | 0,78 | 0,75 |
| Gerek 79 | 0,69 | 0,66 | 0,92 | 0,89 | 0,79 |
| Dağdaş 94 | 0,46 | 0,65 | 0,85 | 0,71 | 0,67 |
| Bezostaja 1 | 0,72 | 0,90 | 0,92 | 0,85 | 0,85 |
| Göksu 99 | 2,35 | 1,94 | 1,57 | 1,79 | 1,91 |
| Konya 2002 | 0,81 | 1,21 | 0,99 | 1,01 | 1,00 |
| BDME 09/1K | 0,86 | 0,56 | 0,91 | 0,94 | 0,82 |
| BDME 09/2K | 0,69 | 0,82 | 0,77 | 0,72 | 0,75 |
| 08-09 KEBVD 24 | 1,26 | 1,18 | 0,98 | 1,05 | 1,12 |
| **Drought Intensity (%)** | **15,3** | **16,6** | **28,8** | **23,7** | **21,1** |

*D1: the general drought that represents the long term drought, D2: the initiation of stem elongation – the initiation of heading stage, D3: the initiation of heading – the finally of flowering stage, D4: grain filling period, D5: full irrigation

According to the average DSI values of genotypes, Goksu 99 cultivar improved for dry conditions was the most susceptible variety by taking the highest DSI values (1.91), as for Dagdas 94 cultivar, it was determined as the most resistance variety with 0.67 DSI values.BDME 09/2K and Bayraktar 2000 genotypes were come to the fore as cultivars which was high the level of drought tolerance, with 0.75 DSI values after Dagdas 94. When genotypes were evaluatedover the drought applications, as Goksu 99 cultivar was the most susceptibility in all drought applications, Bayraktar 2000, Gerek 79, Dagdas 94, Bezostaja 1, BDME 09/2K and BDME 09/1K genotypes exhibited a state more tolerant than the others; as for Karahan 99 cultivar, it showed a pose the susceptible to drought in moderate level that originated from the reason that Karahan 99 had the higher grain yield in irrigated conditions.

Konya 2002 cultivar, outside the early period drought, had the values below 1 in all drought applications. As for 08-09 KEBVD 24 genotype, it showed that it was tolerant to droughtin terms of grain yield with the DSİ values below 1 in drought application (D3) which had to the highest drought intensity, had to drought susceptibility in moderate level in the application of D4, exhibited a susceptible state with the DSİ values above 1 in the applications of D1 and D2. Likewise, some researchers conducted different studies on the drought resistance and the DSI evaluation of bread wheat genotypes has founded the outcomes like to the results obtained in this study (Kalayci et al. 1998; Ozturk, 1999).

*Grain Yield Stability*

Thegrain yield stabilityparameters related the grain yields determined in different drought applications in bread wheat genotypes were given in Table 5.

The grain yields of the Konya 2002, BDME 09/1K, BDME 09/2K, Karahan 99 and Bayraktar 2000 genotypes were above the average yield of trial, the other genotypes had lover yield values than the trial average.Gerek 79, Dagdas 94, Bezostaja 1, BDME 09/1K, BDME 09/2K and 08-09 KEBVD 24 genotypes had to positive “a” values. It was obtained the regression coefficients near to 1 into confidence limits from the genotypes Karahan 99, Bayraktar 2000, BDME 09/1K, BDME 09/2K, 08-09 KEBVD 24 and Gerek 79.

If the stability parameters determined for bread wheat genotypesare evaluated as all together, it can be expressed as the highest of the general adaptation ability of genotypes BDME 09/1K and BDME 09/2K, high of the

general adaptation ability of genotypes Bayraktar 2000 andKarahan 99, have general adaptation of genotypes Gerek 79 and 08-09 KEBVD 24, but better of adaptation to poor conditions.Dagdas 94 was good the special adaptation to environmental conditions which was poor productivity level; as for Bezostaja 1 cultivar, not good the adaptation for both dry conditions and wet conditions, that Konya 2002 cultivar had to special adaptation for wet conditions, but it was determined that Konya 2002 didn't loss very the grain yield in poor environments.It can be expressed that Goksu 99 was good the special adaptation to wet conditions and can increase the grain yield at the highest rate when it was good conditions.That some bread wheat genotypes mentioned in this study located, in some researches which conducted to determine the grain yield stability under dry conditions in the Central Anatolia were reported the results confirmed the findings obtained in this study (Kalayci et al. 1998; Taner et al. 2004).

**Table 5**. The stability parameters related the grain yields determined in different drought applications in bread wheat genotypes

| **Genotypes** | **Avg. Yield (kg ha$^{-1}$)** | **Intercept a** | **Regression coefficient b** | **Deviations of Regression M.S. $S^2$** | **$R^2$** |
|---|---|---|---|---|---|
| (1)Karahan 99 | 7074 | -98,18 | 1,195* | 2237,76 | 0,67 |
| (2)Bayraktar 2000 | 6853 | -16,92 | 1,042* | 9963,26 | 0,71 |
| (3)Gerek 79 | 6625 | 100,70 | 0,834* | 1991,56 | 0,61 |
| (4)Dağdaş 94 | 6388 | 122,05 | 0,776 | 3626,78 | 0,56 |
| (5)Bezostaja 1 | 6007 | 152,18 | 0,664 | 8215,21 | 0,48 |
| (6)Göksu 99 | 5686 | -486,54 | 1,566 | 11972,70 | 0,78 |
| (7)Konya 2002 | 7552 | -88,72 | 1,252 | 7032,67 | 0,77 |
| (8)BDME 09/1K | 7306 | 91,06 | 0,949* | 2554,86 | 0,66 |
| (9)BDME 09/2K | 7271 | 126,82 | 0,891* | 4145,52 | 0,60 |
| (10)08-09 KEBVD 24 | 6637 | 96,92 | 0,841* | 10259,00 | 0,50 |

*(p>0.05)

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