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Determination of Some Quality Characteristics in Winter and Facultative Bread Wheat (*Triticum aestivum* L.) Varieties

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Abstract: Beside their high grain yields, bread wheat varieties should have proper quality characteristics desired by different consumer groups. In this study, some quality characteristics (grain moisture content, flour yield, flour ash content, falling number, wet gluten content and sedimentation volume) of 25 bread wheat varieties taken for adaptation experiments under Erzurum conditions during the crop years of 2001-02 and 2002-03 were investigated. With regard to investigated characteristics, significant differences ($p<0.01$) were observed among varieties and year x variety interactions were also found to be significant. It was concluded in this research with regard to yields obtained from adaptation experiments and quality characteristics obtained from this study that the variety Turkmen with facultative characteristic and white grains could be recommended for this region.

Key words: Winter wheat, facultative wheat, bread, quality

INTRODUCTION

Wheat is the leading basic and strategic food item and has the first place among the culture crops in Turkey with 8.9 million ha sowing area, 19.7 million tons production and 2210.3 kg ha^{-1} yield (Anonymous, 2010). It has a significant place in Turkish economy and agricultural activities and a significant cereal crop dominating the agricultural characteristic of Turkish agriculture and Northeastern Anatolia region. Wheat is the main cereal crop cultivated in Erzurum province of this region. In Erzurum, wheat is cultivated over 43% of cultivated 271.115 ha land area (116.898 ha) and the yield of province is 1590.0 kg ha^{-1} (Anonymous, 2008). Unit area yield of the province is much lower than the already low country average yield.

One of the reasons for low yield levels in wheat culture of Erzurum region is the cultivation of Kirik local variety with low yield potential and low reaction to water and fertilizers over almost 60% of wheat culture lands. Producers prefer this variety since it is suitable for traditional bread production it has facultative characters and white grains. Although, there are various high yield varieties (Dogu 88, Karasu 90, Palandoken 97 and Nenehatun) registered for the regional conditions and able to adopt both irrigated and dry conditions, these varieties were not able to be widespread and were not adopted sufficiently by local farmers. It was mostly due to lack of introduction of these varieties to local farmers, their improper quality characteristics and untimely sowing of these varieties because of various reasons. Unless the new varieties with white grains, high quality characteristics for bread production, high yield potential, resistant to cold and drought are developed and introduced to region, the variety Kirik will keep its dominance among the local farmers and will still be favorite variety of the farmers in upcoming future (Bulut, 2005).

Considering also the recent changes in climate and global warming, development of stable, high yield, disease and pests resistant quality wheat varieties is the most significant purpose of breeding researches (Kaya, 2006).

Beside the climate and soil like environmental conditions and cultivation techniques, genotype is also a significant factor effecting the physical, chemical and technological characteristics determining the quality of wheat (Peterson *et al*., 1992; Otteson *et al*., 2008).

Quality characteristics should not be disregarded while determining the high yield bread wheat varieties suitable for the region and wide spreading the cultivation of these varieties. In this study, quality characteristics of 25 bread wheat varieties of which previously adaptation, yield and agricultural characteristics were determined under Erzurum conditions (Caglar *et al*., 2006) were investigated.

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MATERIALS AND METHODS

Experiments were carried out research fields of number 4 well experiment site of Ataturk University Agricultural Faculty, Agricultural Research and Extension Center under natural precipitation conditions. As the plant material of the research, 25 bread wheat varieties of which adaptation experiments were performed previously (Caglar *et al*., 2006) were used in experiments and definitive information about these varieties was shown in Table 1. The variety Dogu 88 was used as standard variety in this study.

Soil texture of experimental fields are clay-loam with pH of 7.5-7.8 and organic material content of 1.44-1.90%, available P_2O_5 and K_2O contents of 389-436 and 539-602 kg ha^{-1}, respectively.

Meteorological data for experimental crop years were shown in Table 2. Annual total precipitations for crop years 2001-02 and 2002-03 were 499.4 and 368.2 mm, respectively. The first crop year had lower precipitation than long term averages and the 2nd year had precipitation equal to long-term averages. Annual average temperatures were lower than long-term averages in both crop years. The low temperatures of -1.5 and -1.8°C observed, respectively on 6th June 2003 and 25th June 2003 during the second crop year negatively affected the flower fertility of entire varieties.

Experiments were performed in randomized block design with 4 replications. Experiments were set up over fallow lands during both crop years. Sowing was

Table 1: Short descriptive information about bread wheat varieties used in the experiment

Variety name	Variety registered by and registration date	Growth nature	Kernel color
Aksel 2000	Field Crops Central Research Institute, Ankara-2000	Facultative	Red
Alparslan	Eastern Anatolia Agricultural Research Institute, Erzurum-2001	Winter	Red
Atay 85	Anatolia Agricultural Research Institute, Eskisehir-1985	Winter	White
Bayraktar 2000	Field Crops Central Research Institute, Ankara-2000	Facultative	White
Bolal 2973	Anatolia Agricultural Research Institute, Eskisehir-1970	Facultative	Red
Dagdas 94	Bahri Dagdas International Winter Cereal Research Center, Konya-1994	Facultative	White
Demir 2000	Field Crops Central Research Institute, Ankara-2000	Facultative	Red
Dogu 88	Eastern Anatolia Agricultural Research Institute, Erzurum-1990	Winter	Red
Gerek 79	Anatolia Agricultural Research Institute, Eskisehir-1979	Winter	White
Gun 91	Field Crops Central Research Institute, Ankara-1991	Winter	Red
Ikizce 96	Field Crops Central Research Institute, Ankara-1996	Winter	Red
Kate A-1	Trace Agricultural Research Institute, Edirne-1988	Winter	Red
Kinaci 97	Bahri Dagdas International Winter Cereal Research Center, Konya-1997	Winter	Red
Kirgiz 95	Anatolia Agricultural Research Institute, Eskiþehir-1995	Winter	White
Kirkpinar 79	Trace Agricultural Research Institute, Edirne-1979	Facultative	White
Kutluk 94	Anatolia Agricultural Research Institute, Eskisehir-1994	Winter	White
Mizrak	Field Crops Central Research Institute, Ankara-1998	Facultative	White
Nenehatun	Eastern Anatolia Agricultural Research Institute, Erzurum-2001	Winter	White
Palandoken 97	Eastern Anatolia Agricultural Research Institute, Erzurum-1997	Winter	White
Pehlivan	Trace Agricultural Research Institute, Edirne-1998	Winter	Red
Sultan 95	Anatolia Agricultural Research Institute, Eskisehir-1995	Winter	White
Türkmen	Field Crops Central Research Institute, Ankara-1998	Facultative	White
Uzunyayla	Field Crops Central Research Institute, Ankara-1998	Facultative	White
Yakar 99	Field Crops Central Research Institute, Ankara-1999	Facultative	White
Yildiz 98	Anatolia Agricultural Research Institute, Eskisehir-1998	Winter	White

Table 2: Some meteorological data belongs to crop year and long-term average of Erzurum Province

	Total rainfall (mm)			Average temp. (°C)			Maximum temp. (°C)		Minimum temp. (°C)	
Months	2001-02	2002-03	1950-02	2001-02	2002-03	1950-02	2001-02	2002-03	2001-02	2002-03
September	3.8	18.1	34.4	14.3	13.6	13.8	28.2	28.4	-0.6	-0.3
October	51.2	42.9	27.9	6.2	8.9	7.2	25.2	24.0	-8.3	-10.8
November	39.6	25.6	20.5	2.6	1.3	0.9	16.0	16.2	-34.3	-11.8
December	35.1	19.7	23.3	-5.1	-12.0	-5.5	5.8	6.0	-30.0	-37.2
January	14.0	17.7	17.3	-16.1	-7.7	-9.7	4.0	4.2	-33.2	-26.2
February	8.9	30.7	16.2	-3.4	-8.2	-10.2	4.0	4.1	-24.0	-29.2
March	37.4	32.9	55.6	-1.0	-6.6	-4.2	14.2	4.6	-17.2	-28.2
April	81.2	81.4	50.5	4.2	4.4	5.6	15.8	16.4	-8.6	-22.4
May	73.1	29.9	59.3	9.8	11.6	10.4	24.0	24.4	-4.2	-7.1
June	74.0	45.7	31.7	14.3	14.5	15.3	28.0	27.2	2.2	-1.8
July	39.1	18.5	23.6	18.3	18.9	19.9	31.0	31.2	5.2	4.4
August	54.6	5.1	8.4	16.6	20.0	19.5	30.8	34.0	4.8	5.0
Total/Mean	499.4	368.2	368.7	5.1	4.9	5.3	-	-	-	-

performed with pressed plot seeder at a rate of 475 seeds m^{-2} (Akkaya, 1994) during the Winter sowing period recommended for Erzurum region (Akkaya and Akten, 1989). Each plot had dimensions of 1.2×6.0 m with 6 plant rows 20 cm apart from each other. Plots were fertilized at rates of 6 kg da^{-1} N and 5 kg da^{-1} P_2O_5. Half of nitrogen and all of phosphorus were applied during the sowing and the remaining half of nitrogen was applied at the beginning of stem elongation period. Weed control was performed by chemical methods. Harvest was performed at full ripening period with a plot combined-harvester by removing 1 row from plot sides and 50 cm from plot beginnings.

Wheat quality characteristics of grain moisture content, flour yield, flour ash content, falling number, wet gluten content and sedimentation volume parameters were investigated in this research. Quality analyses were performed at quality analysis laboratories of Ataturk University, Agricultural Faculty, Food Engineering Department.

Flour yield was determined in accordance with Seckin (1975) and flour ash content in accordance with Ozkaya (1978). Other quality analyses were evaluated using Standard Methods of the International Association of Cereal Chemistry (ICC) (1986). Whole kernels were analysed for moisture content (Method 110, International Association of Cereal Chemistry (ICC), 1986). The falling number values were determined according to ICC standard 107 (International Association of Cereal Chemistry (ICC), 1986). Wet gluten content of flour samples was determined by ICC method 106 (International Association of Cereal Chemistry (ICC), 1986) and expressed on a 14% moisture basis. Sedimentation volume values were determined by the Zeleny sedimentation test according to ICC standard 116 (International Association of Cereal Chemistry (ICC), 1986).

Analysis of varience was performed with the MSTAT-C (1991) software package. Duncan's multiple range test was used to determine the differences among the means.

RESULTS AND DISCUSSION

Mean values for wheat quality characteristics of crop years were shown in Table 3. Significant differences ($p<0.01$) were observed among all varieties with regard to investigated characteristics. Since, the order of varieties were different with regard to years and year x variety interactions were found to be significant and mean values were presented separately for years.

Since, the characteristics of grain yield, 1000 grain weight, hectoliter weight and grain protein content were provided in another research (Caglar *et al*., 2006) they were not repeated here in this study.

Grain moisture contents of varieties used in experiments varied between 12.1-13.3% during the 1st year and between 10.8-13.6% during the 2nd year of the experiments. Mean grain moisture content of the 1st year (12.7%) was found to be higher than the one in 2nd year (12.3%). While the variety Alparslan had the highest moisture content during the 1st year (13.3%), variety Uzunyayla had the highest value during the 2nd year (13.6%). While Kutluk 94 had the lowest moisture content in the 1st year (12.1%), Palandoken had the lowest value in the 2nd year (10.8%). High precipitation rates during the 1st year (Table 2) and especially the ripening period caused to have higher moisture contents during the 1st year (Table 3). Wheat moisture content is a significant issue in grain storage and milling operations. Since, higher moisture contents reduce the amount of dry matter it reduces commercial value of the wheat and makes the storage difficult because higher moisture contents provoke germination through bacteria and fungus activities. There are several factors effective on wheat moisture content like cultivation and storage conditions and harvest period (Elgun *et al*., 1999). Grain moisture content of Turkish wheat varies between 8-14% with an average of 9-11%. The value of 14.6% is the upper limit for moisture content (Unal, 2002). As found in this study, grain moisture contents (10.8-13.6%) were between normal limits. The values for this parameter are in accordance with the results of other researchers (Ekinci and Unal, 2002; Tayyar, 2005).

It can be shown from Table 3 in where flour yields were presented, average flour yield of the 1st year (62.5%) with better climate conditions (Table 2) was higher than the one in the other crop year (59.9%). Flour yields of varieties varied between 52.4-67.9% during the crop year of 2001-2002. Together with variety of Turkmen, the varieties of Pehlivan, Alparslan, Kate A-1, Aksel 2000, Sultan 95, Ikizce 96, Gun 91, Yakar 99, Demir 2000, Dogu 88 and Bolal 2973 had the highest flour yields and the varieties of Mizrak and Dagdas had the lowest values in this crop year. Average flour yields of varieties varied between 53.4-63.6% during the crop year of 2002-2003. While the varieties Alparslan, Aksel 2000, Turkmen and Sultan 95 had the highest values, the varieties Mizrak, Yakar and Atay 85 had the lowest flour yields. Temperatures and dry weather conditions during the grain filling period of the second crop year (Table 2) shortened the ripening period, caused to have weak and smaller grains and consequently significantly lower flour yields during this crop year. Flour yield of wheat decreases and ash content increases with the increase in small grain ratio

Table 3: Variety means for investigated characters of 25 bread wheats in 2001-02 and 2003-03 growing seasons, respectively

	Grain moisture content (%)		Flour yield (%)		Flour ash content (%)	
Varieties	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03
Aksel 2000	12.6^{bcde}	13.3^{b}	65.2^{abc}	63.4^{a}	0.50^{a}	0.40^{de}
Alparslan	13.3^{a}	12.8^{de}	66.5^{ab}	63.6^{a}	0.43^{ab}	0.40^{de}
Atay 85	12.7^{abcde}	13.3^{b}	57.5^{h}	53.8^{ijk}	0.40^{b}	0.50^{bc}
Bayraktar 2000	12.7^{abcde}	12.8^{de}	63.6^{bcdef}	59.3^{defg}	0.43^{ab}	0.47^{bcd}
Bolal 2973	12.8^{abcd}	12.1^{g}	64.3^{abcdef}	59.3^{defg}	0.50^{a}	0.53^{ab}
Dagdas 94	12.9^{abcd}	13.0^{bcd}	53.0^{ij}	60.6^{cde}	0.50^{a}	0.60^{a}
Demir 2000	12.9^{abcd}	12.5^{f}	64.5^{abcde}	56.3^{hi}	0.50^{a}	0.47^{bcd}
Dogu 88	12.6^{abcde}	11.6^{i}	64.4^{abcdef}	56.0^{ij}	0.40^{b}	0.40^{de}
Gerek 79	12.7^{abcde}	12.8^{de}	64.0^{bcdef}	61.0^{bcd}	0.40^{b}	0.47^{bcd}
Gun 91	12.7^{abcde}	11.3^{j}	64.6^{abcde}	57.4^{ghi}	0.43^{ab}	0.60^{a}
Ikizce 96	12.9^{abcd}	12.0^{gh}	64.7^{abcde}	59.1^{defg}	0.50^{a}	0.50^{bc}
Kate A-1	12.8^{abcd}	12.5^{f}	65.8^{ab}	59.1^{defh}	0.43^{ab}	0.40^{de}
Kinaci 97	12.3^{de}	11.8^{hi}	62.9^{bcdef}	58.6^{efg}	0.40^{b}	0.50^{bc}
Kirgiz 95	12.7^{abcde}	13.0^{cd}	60.7^{fgh}	60.9^{bcd}	0.50^{a}	0.50^{bc}
Kirkpinar 79	12.4^{bcde}	11.7^{i}	61.1^{efgh}	59.7^{def}	0.40^{b}	0.33^{e}
Kutluk 94	12.1^{e}	11.8^{hi}	58.1^{gh}	58.6^{efg}	0.40^{b}	0.40^{de}
Mizrak	12.5^{bcde}	12.8^{de}	52.4^{i}	53.0^{k}	0.46^{ab}	0.53^{ab}
Nenehatun	13.0^{abc}	12.8^{de}	61.5^{cdefg}	58.0^{fghi}	0.50^{a}	0.50^{bc}
Palandoken 97	12.9^{abcd}	10.8^{k}	61.4^{defg}	58.2^{fghi}	0.40^{b}	0.50^{bc}
Pehlivan	13.0^{abc}	13.3^{bc}	66.1^{ab}	59.8^{cdef}	0.50^{a}	0.33^{e}
Sultan 95	12.4^{bcde}	12.6^{ef}	65.0^{abcd}	62.0^{abc}	0.40^{b}	0.50^{bc}
Turkmen	12.8^{abcd}	12.6^{ef}	67.9^{a}	63.1^{ab}	0.40^{b}	0.60^{a}
Uzunyayla	13.0^{abcd}	13.6^{a}	63.9^{bcdef}	59.7^{def}	0.50^{a}	0.50^{bc}
Yakar 99	12.3^{cde}	11.3^{j}	64.6^{abcde}	53.4^{k}	0.40^{b}	0.50^{bc}
Yildiz 98	12.3^{cde}	11.1^{ij}	57.6^{h}	57.7^{fghi}	0.43^{ab}	0.43^{cd}
Mean	12.7	12.3	62.5	58.9	0.40	0.50
LSD	0.67	0.27	3.72	2.26	0.07	0.10
C.V. (%)	2.41	0.95	2.72	1.75	6.33	8.17

	Falling number (sec)		Wet gluten content (%)		Sedimentation volume (mL)	
Varieties	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03
Aksel 2000	560.0^{defg}	950.70^{b}	27.8^{d}	36.8^{ghi}	44.1^{a}	51.7^{c}
Alparslan	380.7^{kl}	312.00^{m}	23.1^{hi}	49.6^{a}	42.9^{b}	63.2^{a}
Atay 85	631.7^{cd}	714.00^{efgh}	24.5^{fg}	38.9^{efg}	30.3^{ijk}	26.3^{lm}
Bayraktar 2000	237.7^{m}	426.00^{k}	22.0^{i}	37.7^{fgh}	27.6^{no}	35.9^{ijk}
Bolal 2973	500.7^{ghi}	722.00^{efgh}	23.1^{hi}	41.0^{cde}	28.9^{lm}	41.4^{ef}
Dagdas 94	742.0^{b}	1054.00^{a}	25.5^{ef}	39.5^{cdef}	23.7^{r}	33.6^{k}
Demir 2000	876.0^{a}	602.00^{j}	35.7^{a}	41.5^{c}	39.8^{c}	39.3^{efgh}
Dogu 88	879.7^{a}	808.70^{c}	23.0^{hi}	37.6^{fgh}	42.8^{b}	64.5^{a}
Gerek 79	558.7^{defg}	684.00^{ghi}	28.5^{cd}	35.5^{hi}	28.2^{mn}	37.9^{ghij}
Gun 91	872.0^{a}	662.70^{hij}	26.2^{e}	41.7^{c}	38.2^{d}	59.1^{b}
Ikizce 96	890.0^{a}	751.00^{cdeg}	25.2^{ef}	44.3^{b}	29.8^{kl}	44.4^{d}
Kate A-1	506.0^{ghi}	787.00^{cd}	26.3^{e}	45.5^{b}	31.5^{j}	35.2^{jk}
Kinaci 97	595.0^{def}	684.70^{ghi}	27.9^{ij}	39.4^{cdef}	29.7^{kl}	38.2^{d}
Kirgiz 95	341.0^{l}	353.00^{lm}	25.6^{ef}	39.4^{cdef}	22.2^{s}	28.6^{l}
Kirkpinar 79	542.7^{efgh}	706.00^{fgh}	26.0^{e}	41.5^{c}	25.3^{q}	24.5^{m}
Kutluk 94	467.0^{ij}	415.70^{kl}	27.9^{d}	41.3^{cd}	26.5^{p}	38.6^{fghi}
Mizrak	688.7^{bc}	806.70^{c}	29.5^{c}	40.2^{cde}	36.5^{e}	33.9^{k}
Nenehatun	570.0^{defg}	694.00^{fgh}	27.6^{d}	34.6^{i}	26.6^{op}	33.6^{k}
Palandoken 97	422.7^{jk}	602.70^{j}	23.4^{gh}	30.2^{j}	25.8^{pq}	39.0^{fghi}
Pehlivan	500.0^{ghi}	1041.00^{a}	28.6^{cd}	48.2^{a}	36.1^{ef}	40.3^{efg}
Sultan 95	477.7^{hij}	778.00^{cde}	35.6^{a}	39.1^{defg}	34.8^{g}	39.7^{efgh}
Turkmen	537.0^{fghi}	711.00^{fgh}	32.4^{b}	49.8^{a}	38.9^{cd}	49.8^{c}
Uzunyayla	611.7^{de}	729.70^{defg}	20.7^{j}	37.2^{fgh}	30.9^{u}	42.0^{de}
Yakar 99	751.7^{b}	736.70^{defg}	32.9^{b}	34.7^{i}	35.3^{fg}	51.0^{c}
Yildiz 98	343.0^{l}	624.00^{ij}	28.1^{d}	36.7^{ghi}	32.9^{h}	37.3^{hij}
Mean	579.3	694.30	26.8	40.1	32.4	41.2
LSD	73.39	64.36	1.30	2.40	1.06	2.77
C.V. (%)	5.780	4.23	2.21	2.73	1.50	3.07

(Shuey and Gilles, 1969). On the other hand, sedimentation and amount of gluten decrease with an increase in flour yield (Seckin, 1975). The results for flour yields of this study are similar to the ones observed by the other researchers (Seckin, 1974; Ertugay, 1981).

The mean values for flour ash content of the varieties were shown in Table 3. While the mean ash content of flour as an average of all varieties was 0.40% in the first crop year this value increased to 0.50% with the decrease in flour yield in the second crop year. Flour ash contents

varied between 0.40-0.50% during the first crop year, this contents were between 0.33-0.60 during the second crop year. Variety x year interaction was found to be significant. While the varieties Dagdas 94, Mizrak and Gun 91 had the highest ash contents during both crop years, the varieties Kirkpinar 79, Alparslan, Dogu 88 and Kutluk had the lowest values. Ash content of wheat is closely related to flour yield and ash contents of flours of different wheat with the same yield can exhibit minor differences and high ash contents are not desired (Unal, 2002). Dry climate conditions of the second crop year (Table 2) caused to have higher ash contents. It is known that ash content varies especially based on climate conditions during ripening period (Zwingelberg, 1961), varieties and nitrogenous fertilization has a reducing impact of ash content (Fine, 1972). General average of flour ash content was 0.45% in this study and this value is in accordance with the values specified in other literatures (Ozkaya, 1978; Ertugay and Elgun, 1986).

Variation in falling numbers was between 237.7-879.7 s during the first crop year and between 312.0-1054.0 s during the second crop year. The falling number as the average of all varieties in the 1st year (579.3 s) was significantly lower than the one in the 2nd year (694.3 s). Falling number of wheat is a parameter used to determine the diastatic activity of flour and it is a significant parameter with regard to the amount gas during bread production and volume of bread. The time period for viscosity loss of wheat starch with the activity of amylase enzymes in flour is expresses as falling number in seconds (s) (Unal, 2002). The desired falling number of wheat should be between 220-250 s (Diepenbrock *et al*., 2005). In this study, only the variety Bayraktar 2000 yielded a falling number of 237.7 s in the first crop year indicating normal enzyme activity. Except this variety in the 1st year, all the other varieties yielded excessive falling numbers above the acceptable limits in both years. Lower falling numbers in the 1st year of the experiments as shown in Table 2 are related to higher precipitations during the starch formation period of this year (Erekul *et al*., 2009). Unal (2002) stated reductions in volume and quality of breads made of flours with falling numbers higher than acceptable limits unless adding enzymes into flour and also stated that bread paste was not able to produce sufficient gas and crumb would be tight in breads made of these flours. Researcher recommends the mixture of high falling number flours with lower ones to improve the flour quality. Erekul *et al*. (2009) indicated that number of falling number could vary based on weather conditions and wheat varieties. Same researhers in a 2 years study determined the number of falls for 18 wheat genotypes between 211-471 s for the 1st year and between 224-523 s for the 2nd year of their experiments and they observed significant differences among varieties. Unstable character of falling numbers with regard to years caused to have significant year x variety interactions.

Wet gluten contents of wheat varieties used as the material of this study was found to be between 21.9-35.7% for the first crop year and between 30.2-49.8% for the second crop year. The highest mean of gluten (40.1%) was obtained during the 2nd year of experiments. Mean wet gluten of the 1st year was 26.8%. The varieties Demir 2000 (35.7%) Sultan 95 (35.6%) and Turkmen (32.4%) had the highest wet gluten contents during the 1st year of experiments. Except the variety Turkmen, the others were not able to preserve their gluten contents during the 2nd year. Turkmen on the other hand, exhibit a stable state during also the 2nd year of the experiments with the highest content of 49.8% and it was followed by the varieties of Alparslan (49.6%) and Pehlivan (48.2%). Gluten is a significant parameter in wheat for bread production and it is the elastic protein indicating the availability of paste for bread production (Ozturk and Gokkus, 2008). Wet gluten content expresses the amount and characteristics of gluten in protein. The higher wet gluten contents were found to be parallel with the higher grain protein concentrations of the second year with higher temperatures during the grain filling period (Caglar *et al*., 2006) and sedimentation values (Table 3). Ozturk and Aydin (2004) indicated a positive correlation ($r = 0.52$) between wet gluten content and grain protein concentration and stated that water stress increased the wet gluten content. Environmental conditions play an important role in occurrence of qualitative superiority of wheat varieties one over the other and different values were observed in each location and crop year similar to findings of this study (Fajersson, 1968). Gluten forms a webby pattern during the mixture of bread paste keeps CO_2 during the fermentation and provides the production of larger size breads (Tayyar, 2008). Uluoz (1965) classified the wet gluten content of flours as high for >27%, medium for 20-22% and low for below 20%. Taking this classification into consideration, the mean gluten values obtained from the varieties of this study were mostly placed in high quality group. Demir *et al*. (1999) observed closer gluten contents of 22-45% with this study. Ozturk and Gokkus (2008) also found significant differences among varieties and years and significant year x variety interaction.

Sedimentation volumes of flours obtained from bread wheat varieties selected as the plant material of this study varies significantly with regard to varieties and year x variety interaction was also found to be significant. Proper weather conditions during the 1st year of the experiments caused a decrease in sedimentation volume as it was wet gluten contents and the mean sedimentation value for this year (32.4 mL) was found to be lower than

the one obtained during the 2nd year (41.2 mL). Similarly, Ozturk and Aydin (2004) also observed higher sedimentation values for the drier year of their experiments. While the sedimentation values were between 22.2-44.1 mL for the 1st year, these values were between 24.5-64.5 mL for the 2nd year. Although, most of the varieties were not able to exhibit stable state with regard to sedimentation values, the varieties Dogu 88, Alparslan, Aksel 2000, Gun 91 and Turkmen exhibited more stable state and yielded higher values for both years (Table 3). Sedimentation value expresses the volume of plastic extract formed by swelling of wheat flour through water intake in aqueous weak acids. It also indicates the amount and quality of gluten and it is also a parameter used to estimate the protein concentrations of wheat with the same gluten quality. Higher values for this parameter indicates higher water retention of gluten and larger size breads made of these flours (Elgun *et al*., 2001). According to Unal (2002), bread wheat are classified as very good for zeleny sedimentation values >30 mL, good for 25-30 mL, medium for 20-25 mL, weak for 15-20 mL and bad for <15 mL. With regard to this classification, most of the varieties of this study exhibited very well sedimentation characteristics. Ozturk and Gokkus (2008) observed the sedimentation volumes of varieties between 26.0-43.3 mL; Bayram *et al.* (2008) between 34.6-56.0 mL. According to Atli and Kocak (2004), zeleny sedimentation volume is under the effect of inheritance and differences are mostly dependent of genotypes. Climate factors are also effective over this parameter. Unstable behaviors of wheat varieties with regard to sedimentation volumes caused to have significant year x variety interaction. In fact, similar to findings of this study, Ozturk and Gokkus (2008) also stated that order of wheat varieties with regard to sedimentation volumes exhibited significant variations between years.

Severe winter months are experienced in Northeastern region of Turkey in which the province of Erzurum is located due to dominant terrestrial climate conditions. Late harvest of summer crops like potato and sugar beet in the region, winter wheat is not mostly able to be sown on time. Therefore, wheat sowing is performed at relatively late autumn by using facultative variety Kirik in buried (Freezing sowing) fashion and at generally spring as summer sown. Yield in summer sowing is almost half of the yield in winter sowing and yield in frozen sowing is relatively higher than summer sowing (Ozturk *et al*., 2006). Since, there has not been any other alternative variety in the region, local farmers disregard the yield and usually prefer the local variety of Kirik with low yield capacity but with superior quality characteristics. They do not prefer the winter varieties due to limited sowing periods and low quality characteristics. To increase the wheat yield in the region, facultative high yield and cold-resistant varieties should be introduced to the region and quality characteristics should always be taken into consideration as the prior issue. For this purpose, a total of 25 bread wheat varieties of which adaptation experiments under Erzurum conditions were performed, yield and agricultural characteristics were investigated previously (Caglar *et al*., 2006) were evaluated in this study with regard to quality characteristics (15 of varieties were definitely winter and 10 of them had facultative characters).

CONCLUSION

In this study, the results revealed that the white-grained variety Turkmen with facultative character had superior performance with regard to most of the quality characters and considering yield values of this variety during the adaptation experiments it can be recommended for the region.

REFERENCES

Akkaya, A. and S. Akten, 1989. Effects of different sowing times on yield and some other yield parameters of winter-sown wheat varieties under Erzurum dry conditions. Turk. J. Agric. For., 13: 913-923.

Akkaya, A., 1994. Effects of different sowing spacing on yield and some other yield parameters of two winter-sown wheat varieties under Erzurum conditions. Turk. J. Agric. For., 18: 161-168.

Anonymous, 2008. Statistics of Provincial Directorate of Agriculture, Erzurum, Turkey (In Turkish).

Anonymous, 2010. Turkish Statistical Institute. Plant Production Statistics. http://www.tuik.gov.tr.

Atli, A. and N. Kocak, 2004. Estimation of bread wheat quality in breeding programs with different sedimentation tests. J. Harran Univ. Agric. Faculty, 8: 1-56.

Bayram, M.E., I. Ozseven, L. Demir and S Orhan, 2008. Investigation of grain yields and some quality parameters of advanced lines in South Marmara region bread wheat breeding studies. Proceedings of the National Cereal Symposium, June 2-5, 2008, Konya, Turkey, pp: 176-784.

Bulut, S., 2005. Effect of sowing time and seeding rate on plant growth and yield of wheat cv. Kirik. M.Sc. Thises, Ataturk University, Graduate School of Natural and Applied Sciences, Department of Field Crops, Erzurum.

Caglar, O., A. Ozturk and S. Bulut, 2006. Adaptation of some bread wheat cultivars in Erzurum Plain conditions. J. Ataturk Univ. Agric. Fac., 37 : 1-7.

Demir, I., S. Yuce, S. Sekin, E. Kose and C. Sever, 1999. A research on determination of some quality characteristics of advanced bread wheat lines. Proceedings of the 3rd National Field Crops Congress, November 15-18, 1999, Adana, Turkey, pp: 354-356.

Diepenbrock, W., F. Ellmer and J. Leon, 2005. Ackerbau pflanzebauund pflanzenzuchtung Stuttgart. Verlang Eugen Ulmer, Germany.

Ekinci, R. and S.S. Unal, 2002. Characteristics of different type flours produced in different regions of Turkey. Food, 27: 201-207.

Elgun, A., S. Turker and N. Bilgicli, 2001. Cereal and Cereal Products Analytical Quality Control. Selcuk University, Agricultural Faculty, Department of Food Engineering, Publication Number 2, Konya, Turkey.

Elgun, A., Z. Ertugay, M. Certel and H.G. Kotancilar, 1998. Cereal and Cereal Products Analytical Quality Control and Laboratory Manual. 2nd Edn., Ataturk University Publication, Istanbul, Erzurum, Pages: 245.

Elgun, A., Z. Ertugay, M. Certel and H.G. Kotancilar, 1999. Cereal and Cereal Products Analytical Quality Control and Laboratory Manual. 2nd Edn., Ataturk University Publication, Turkish, Pages: 245.

Erekul, O., T. Kautz, F. Ellmer and I. Turgut, 2009. Yield and bread-making quality of different wheat (*Triticum aestivum* L.) genotypes grown in Western Turkey. Arch. Agron. Soil Sci., 55: 169-182.

Ertugay, Z. and A. Elgun, 1986. A study on technical characteristics of wheat varieties adapted to Erzurum. J. Ataturk Univ. Agric. Fac., 17: 17-23.

Ertugay, Z., 1981. Studies of breadmaking quality of Kirik wheat (*Triticum aestivum* L. *var. delfii*) growing in Eastern Anatolia. J. Ataturk Univ. Agric. Fac., 12: 17-40.

Fajersson, D.F., 1968. Variation in quality of Swedish proven wheat from the breeders. Vie W point. Getreide Mehl., 18 : 53-56.

Fine, L.O., 1972. Mineral content of South Dakota common wheat: Extent and nature. Agron. J., 64: 769-772.

International Association of Cereal Chemistry (ICC), 1986. Standard Methods of the ICC. ICC, Vienna.

Kaya, A., 2006. Determination of agronomical and technological characteristics of bread wheat genotypes in upland and lowland conditions of Cukurova. M.Sc. Thises, University of Cukurova, Institute of Natural and Applied Sciences, Department of Field Crops. Adana, Turkey.

MSTAT-C, 1991. A Software Programme for the Design, Management and Analysis of Agronomic Research Experiments. Michigan State University, East Lansing, MI., USA.

Otteson, B.N., M. Merqoum and J.K. Ransom, 2008. Seeding rate and nitrogen management on milling and baking quality of hard red spring wheat genotypes. Crop Sci., 48: 749-755.

Ozkaya, H., 1978. Researches on flour and bread quality of mixtures of Kose 220/39 and Bezostaja wheat varieties with other varieties and rye. Ph.D. Thesis, Ankara, Turkish.

Ozturk, A. and F. Aydin, 2004. Effect of water stress at various growth stages on some quality characteristics of winter wheat. J. Agron. Crop Sci., 190: 93-99.

Ozturk, A., O. Caglar and S. Bulut, 2006. Growth and yield response of facultative wheat to winter sowing, freezing sowing and spring sowing at different seeding rates. J. Agron. Crop Sci., 192: 10-16.

Ozturk, I. and A. Gokkus, 2008. The effects of nitrogen fertilization on grain yield and quality in some bread wheat varieties. J. Agric. Sci., 14: 334-340.

Peterson, C.J., R.A., Graybosch, P.S. Baenziger and A.W. Grombacher, 1992. Genotype and environment effects on quality characteristics of hard red winter wheat. Crop Sci., 32: 98-103.

Seckin, R., 1974. Researches of milling functions, chemical compositions and bread quality of Bezostaja wheat produced under different environmental conditions. Ann. Book Ankara Univ. Agric. Fac., 3: 285-297.

Seckin, R., 1975. Effect of efficiency in some bread wheat varieties produced in Turkey on chemical composition of flour and bread quality. Ankara University Agricultural Faculty Publications, Publication No. 569, Ankara, Turkey.

Shuey, W.C. and K.A. Gilles, 1969. Experimental milling of sized wheat. North Western Miller, 266: 9-13.

Tayyar, S., 2005. Determination of yield and some quality characteristics of different bread wheat (*Triticum aestivum* L.) varieties and lines grown in Biga. J. Akdeniz Univ. Agric. Fac., 18 : 405-409.

Tayyar, S., 2008. Grain yield and agronomic characteristics of Romanian bread wheat varieties under the conditions of Northwestern Turkey. Afr. J. Biotechnol., 7: 1479-1486.

Uluoz, M., 1965. Wheat, Flour and Bread Analysis Methods. Agricultural Faculty, Publication Number 29, Izmir, Turkey, pp: 91.

Unal, S.S., 2002. Importance of wheat quality and methods in wheat quality determination. Proceedings of the Cereal Products Technology Congress and Exhibition, October 3-4, 2002, Gaziantep, Turkey, pp: 25-37.

Zwingelberg, H., 1961. Beziehungen zwishen gnantzkomasohage halt, Mehlassneghault und mehlfarbe bei weizensorten. Getrede Meh., 10: 117-119.