Research Article

Ekin
Journal of Crop Breeding and Genetics

6(1):54-62, 2020

www.ekinjournal.com

Ekin International biannual peer-reviewed journal

Comparison of Some Triticale and Wheat Varieties in Terms of Yield Over the Locations and Years in Erzurum Conditions

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Citation:
Kucukozdemir U., Bedirhanoglu V., Bagci SA., 2020. Comparison of Some Triticale and Wheat Varieties in Terms of Yield Over the Locations and Years in Erzurum Conditions. Ekin J. 6(1):54-62, 2020.

Received: 10.03.2019 ***Accepted: 12.06.2019*** ***Published Online: 27.01.2020*** ***Printed: 27.01.2020***

ABSTRACT

This study was conducted to determine triticale varieties suitable for the ecological conditions of Erzurum and to compare them with wheat varieties developed for the region in Pasinler and Aziziye locations for a period of ten years (2006-2015) in randomized block design with 3 replications. In this study, 3 bread wheat varieties (Doğu 88, Palandöken 97, Alparslan) and 1 triticale (Ümranhanım) variety and 3 triticale varieties developed by Bahri Dağdaş International Agricultural Research Institute (Tatlıcak 97, Mikham and Melez 2001) for the East Anatolian Region were used as study material. Wheat and triticale varieties were compared with each other in terms of grain yield over the locations and years. There were statistically significant differences ($p<0.01$) between years, locations and varieties. While the average yield of 4403 kg ha^{-1} was obtained from the Pasinler location, 2896 kg ha^{-1} yield was obtained from the Aziziye location on average. According to the results of the ten-year trial, the Ümranhanım triticale variety developed especially for the Eastern Anatolia Region had the highest grain yield (4189 kg ha^{-1}). This was followed by Tatlıcak 97 (4062 kg ha^{-1}), Doğu 88 (3712 kg ha^{-1}), Alparslan (3655 kg ha^{-1}), Palandöken 97 (3575 kg ha^{-1}), Mikham (3389 kg ha^{-1}) and Melez 2001 (2967 kg ha^{-1}) varieties. Therefore, it is concluded that the Ümranhanım and Tatlıcak 97 cultivars can be used as an alternative to wheat varieties grown in the region and higher grain yield can be obtained.

***Keywords*:** Triticale, bread wheat, yield, adaptation

Introduction

About 73% (1.03 million ha) of the agricultural lands of Eastern Anatolia Region which holds an important place in the agriculture of Turkey is comprised of grain planting areas. Approximately 730 thousand ha of this area has been planted with wheat and the yield per hectare is 1500-1700 kg (Anonymous, 2012). Only 25% of the agricultural land in the region can be irrigated. Therefore, agriculture in the region is based on plant species that can be cultivated in dry conditions. The compensatory abilities of cereals as well as their ability to eliminate grower errors and negative conditions to a certain extent earn them a different place among crop plants (Akkaya, 1994). The dry farming system dominates in Eastern Anatolia as well as overall Turkey and therefore cereals have an important place in this system. Furthermore, 539,174 ha of the 13,621,000 ha of land is unsuitable for the agriculture of many crops grown in the region (Anonim, 1996). That is, 20.4% of the total land in the region cannot be used at present. On the other hand, the yield from the unit area in the region is quite low. Therefore, there is a significant gap both in the balanced nutrition of humans and in the provision of feed for animal husbandry. Under the circumstances cereals have a great potential to close the gap in terms of both food grains and animal feed in the world as well as in Turkey. As the winter pre-winter development is good for both cultivated and cold-resistant varieties planted at the appropriate time, both cold resistance

and yield increase. Triticale is less damaged by winter and cold compared to other grain types. The varieties developed especially as a result of breeding studies provide maximum adaptation to the regions where their use is recommended and deliver very high yields. The aim of this study is to examine and compare the long year average yield performance of some triticale and wheat varieties which have high adaptation to the region.

Materials and Methods

Materials

In this study, Doğu 88, Palandöken 97, Alparslan wheat varieties with a significant cultivation area in the region and Ümranhanım triticale variety and 3 triticale varieties developed by Bahri Dağdaş International Agricultural Research Institute, namely Tatlıcak 97, Mikham and Melez 2001 for the East Anatolian Research Institute were used as trial material.

Methods

The research was carried out in Erzurum, Eastern Anatolia Agricultural Research Institute, at two locations viz., Pasinler experimental station at an altitude of 1760 m and Aziziye experimental station at an altitude of 1812 m in Randomized Complete Block Design with 3 replications. In the planting with the parcel seeder, each parcel was composed of 6 rows with a width of 1.2 m and a length of 6 m. Each parcel was arranged in 6 rows with a row spacing of 20 cm and the planting frequency was adjusted to 475 plants per m^2 (Akkaya, 1993). Planting was carried out between September 1 and October 1, which is the most suitable date for winter planting (Akkaya and Akten 1989; Özcan and Acar 1990). Phosphorus and nitrogen fertilizer was used as the source of fertilizer in the trial; half of the nitrogen fertilizer was used with the planting, the other half during the bolting period while all the phosphorus fertilizer was spread with the planting at a rate of 60 kg N and 60 kg P_2O_5 per hectare (Akkaya, 1993; Kıral and Özcan, 1990). When the varieties reached harvest maturity, the remaining parts were harvested and blended with the parcel harvester after 50 cm of the parcel heads were disposed of as edge effect. The methods applied by Akkaya (1993), Kıral and Özcan (1990), Akkaya and Akten (1989), Özcan and Acar (1990) were used for planting, maintenance and harvesting. Grain yield was investigated based on the methods of Uluöz (1965), Genç (1972), Köycü (1974 and 1979) and in this trial.

The data obtained from the trial were analyzed statistically using JUMP 5.0 package programs and compared according to the LSD test.

Climate and Soil Properties of the Test Site:

Total rainfall and temperature data of the locations where the trials were established are given in Tables 1, 2, 3 and 4 for the years 2006-2015.

Among the locations, Aziziye location has a montmorillonite clay type soil structure and the soil properties of both locations are given in Table 5. Penetration resistance in Pasinler location is between 0.5 and 1.5 MPa and in Aziziye location it is 8 MPa. Root development stops at 2.5 MPa penetration resistance. Therefore, yields obtained from Aziziye location are lower than those for the Pasinler location.

Results and Discussion

When the total rainfall and average temperature values of the growing season between October (1-15 September) and harvest (1-15 August) are examined, there are differences between the total rainfall and average temperatures in both locations. Although the yield is directly related to precipitation and temperature, it is more important that the desired climatic conditions occur in the developmental stages of the plants. Differences were determined between years, varieties, locations and interactions at $P<0.01$ level (Table 6). When the yields on the basis of locations and the climate data of the relevant years are analyzed, the highest yields were obtained in Aziziye in 2008 (7098 kg ha^{-1}) and in Pasinler in 2011 (4120 kg ha^{-1}). The highest yields were obtained in 2008 (5054 kg ha^{-1}) and the lowest yields in 2013 (3332 kg ha^{-1}) (Table 7).

In order to obtain high yields, temperature and precipitation must be regular throughout the vegetation period. Negative climatic conditions that occur at any stage of plant development cause significant reductions in yield. Autumn rainfall and temperatures are very important in the Eastern Anatolia Region. In winter planting, if the plants can make a good start, they will be less affected by winter damage. When the rainfall data is analyzed for a long time, it is noted that 23% of the annual rainfall occurs in autumn and 19% during winter months. When plants planted in winter reappear in spring, they benefit from about 40% of total annual precipitation. This is very important for plant development. High yields were obtained in the years when the plants made a good start before winter and thus started winter with a strong root structure. As a matter of fact, Erekul and Köhn (2006) emphasized the importance of a good start of the plants before winter and the thickness of snow during winter months for high yield.

The yield values for the years in which the trial was conducted are presented in Table 7. The differences between genotypes in terms of yield were insignificant

in 2007, significant in 2006 and 2008 (P<0.05) and very significant during other years (P<0.01). When the data obtained over the years are examined, the average yields of triticale varieties were higher than the average yields of wheat varieties during 5 years (2006, 2008, 2009, 2013 and 2014) while the average yields of wheat varieties was higher during the other 5 years. However, it was noted that the annual average yields of triticale varieties were lowered by Mikham and Melez 2001 varieties (Table 7).

Table 8 shows that there is no statistically significant difference between the locations in 2006, 2011, 2013 and 2014, however during the other years there are significant differences (P<0.01). It is very important for plants to make a good start before winter in Eastern Anatolia Region in terms of winter durability. Although there was no statistical difference between the locations in 2006 because there was no climatic negativity in 2007, significant yield losses were incurred in Pasinler location because there was only 3.5 mm precipitation in June during the flowering and pollination period (Table 1). Therefore, the yield from the Pasinler location (3650 kg ha^{-1}) was close to the yield from the Aziziye location (3164 kg ha^{-1}) (Table 8). As there were no climatic problems in 2007, 2008 and 2011, the yields were high, namely 4098 kg ha^{-1}, 3010 kg ha^{-1}, 4120 kg ha^{-1} in Aziziye and 5291 kg ha^{-1}, 7098 kg ha^{-1}, 4181 kg ha^{-1} in Pasinler, respectively. In 2009, low yields affected the Aziziye location which was subjected to hail before harvest in August which caused yield loss (1722 kg ha^{-1}) (Table 8).

In 2012, the lack of sufficient rainfall after planting and very low night temperatures caused insufficient output before winter and low temperatures in spring (-6°C in March) had an adverse impact on plant growth causing yields to decrease to an average of 1527 kg ha^{-1} in Aziziye and 3238 kg ha^{-1} in Pasinler. Low temperature is one of the most important abiotic stresses affecting wheat planting and production. Frost resistance in winter wheat is one of the elements of winter durability (Sutka 1994). Winter wheat and other cereal species must be winter-resistant. The ability to sustain vitality during winter and spring frosts is an important factor in defining the success of winter wheat. Climatic data and winter damage findings have been compared in many locations in Finland, and it was manifested that climate data are related to winter damage levels and that there is an important link between winter damage and yield (Olesen *et al*. 2011). Greer *et al*. (2001) reported that winter wheat developed adaptation mechanisms that compensate for temperature and cold acclimatization processes to increase the viability of seeds while Kovács *et al*. (2011) reported that cold resistance mechanisms were activated during the cold acclimation process. Küçüközdemir and Tosun (2014) determined that registered varieties were more cold resistant in a study under controlled conditions carried out with 180 local and 6 registered varieties and the most resistant genotype was Alparslan which can withstand a temperature of -19°C.

Again in 2014, insufficient rainfall and very low temperatures prevented plants from having a good pre-winter start after planting in the Aziziye location. At the same time, inadequate precipitation for a snow cover in both locations had a negative impact on yield. Rainfall occurred locally in the spring and low temperatures as well as drought adversely affected plant growth. In 2014, 2155 kg ha^{-1} yield was obtained in Aziziye and 2289 kg ha^{-1} yield in the Pasinler location. Tosun *et al*. (2000) carried out a study in Erzurum conditions and obtained grain yields of 1441-2245 kg ha^{-1} while Atak and Çiftçi (2005) carried out a study in Ankara conditions and determined a yield of 2833-3833 kg ha^{-1}. Again Ünsal (2005) reported a grain yield of 200-250 kg ha^{-1} for wheat and barley planted in problematic areas while the grain yield of triticale was 400 to 500 kg ha^{-1}.

When the wheat varieties used in the experiment were evaluated separately, it was seen that there were very important (P<0.01) differences between the years. (Table 9). However, since the varieties were developed for the Eastern Anatolia Region, there was no difference between the location averages. When the locations were evaluated separately, the difference between wheat varieties in Aziziye location was found to be insignificant while the difference in Pasinler location was found to be significant (P<0.05). As shown in Table 10, Pasinler location (Average 4057 kg ha^{-1}) has a higher yield than Aziziye location (3234 kg ha^{-1}). The highest yield of wheat varieties belong to Eastern 88 varieties (3712 kg ha^{-1}) followed by Alparslan (3655 kg ha^{-1}) and Palandöken (3571 kg ha^{-1}), respectively. In fact, Kaydan and Yağmur (2008) carried out a study for two years with 15 registered varieties under Van ecological conditions and the local genotype Tir, which is widely cultivated in Van, and determined that the highest yield was obtained from Doğu 88 (23836 kg ha^{-1}) cultivars while genotype Tir had the lowest yield (16707 kg ha^{-1}). Çağlar *et al*. (2006) investigated the adaptation of 25 bread wheats in Erzurum conditions. The Doğu 88 cultivar developed for the Eastern Anatolia Region had the highest yield (4607 kg ha^{-1}), while the lowest yield was obtained from Kırkpınar 79 cultivars (3024 kg ha^{-1}).

When the triticale varieties used in the experiment were evaluated separately, it was seen that there were very important (P<0.01) differences between the years, varieties, locations and their interactions (Table 11). Since only Ümranhanım variety, which was one of the triticale varieties used as material, was developed for the Eastern Anatolia Region, very important differences were determined between the varieties in both locations and locations averages. As shown in Table 12, Pasinler location (average 4286 kg ha^{-1}) has a higher yield than Aziziye location (3017 kg ha^{-1}).

The cold-resistant Ümranhanım variety developed for the region had the highest yield (4189 kg ha^{-1}) in terms of both location as well as location average of the ten-year, followed by Tatlıcak 97 varieties which has adapted well to the region with 4062 kg ha^{-1}. When the locations were evaluated separately, it was discovered that Ümranhanım and Tatlıcak 97 varieties had higher yields than Mikham (3389 kg ha^{-1}) and Melez 2001 (2967 kg ha^{-1}) varieties and location averages in both locations (Table 12). As can be seen in the same table, the average of the locations is decreased by Melez 2001 and Mikham varieties. In Erzurum conditions, Tosun *et al*. (2000) carried out a study carried and obtained grain yields of 1441-2245 kg ha^{-1} while a study conducted by Atak and Çiftçi (2005) under the conditions of Ankara, they determined yields between 2833-3833 kg ha^{-1}. Küçükbayram and Azkan (2002) emphasized that high grain yield can be achieved with triticales not withstanding sudden arid and hot weather. In 2002, Geren *et al*. reported that seed yields decreased significantly as a result of low and irregular rainfall recorded in parallel with the high temperature in May in the first year and planting 40 days later in the first year than in the second year. In a study conducted in the Republic of South Africa in 2006-07, Du Pisani (2009) emphasized the importance of the effect of years and varieties on grain yield. 6 triticale lines and Doğu 88 varieties in the ecological conditions of Erzurum, Muş, Erzincan and Van provinces were compared in terms of yield and yield components, and one triticale line had higher yields than Doğu 88 (Küçüközdemir, 2002)

Conclusion

According to the results obtained from the study, significant differences were determined among all varieties on the basis of years and locations. Ümranhanım variety, which is resistant to cold and drought, has been identified as having the highest yield among all varieties. This is due to the fact that this variety was developed for the Eastern Anatolia Region. It has been concluded that Ümranhanım and Tatlıcak 97 varieties can be used as an alternative in areas with low yield from wheat due to cold, arid climate conditions and land structure in Eastern Anatolia Region and it is necessary to expand the production of these varieties in order to increase the average yield of cereal in the region.

Table 1. Total monthly precipitation (mm) of the Pasinler Location for 2005-2015

Years	MONTHS												
	9	10	11	12	1	2	3	4	5	6	7	8	Total
2005-06	23	26	60	31	41	35	21	118.9	38.9	3.5	21.7	6	426
2006-07	14	69.5	10.5	5	22	25	113	104	78	54	33	39	567
2007-08	0	28	72.5	36.5	19.5	41	18	20.1	47.7	31.5	3.8	32.5	351.1
2008-09	2	74.4	12	28	18	45	66.3	49.7	33.7	78.8	52.5	14.5	474.9
2009-10	31	44.1	49.4	25	45.6	20.2	71.5	47.9	58.5	32	58.3	4.5	488
2010-11	12	52	0	8.6	20.4	42.5	16	152	56.7	24	20	7.5	411.7
2011-12	16	30	38	27.5	34.5	63	11.5	16	47.5	29	10	15	338
2012-13	72	45.5	29	43	43	41	39	45	32	26.5	7.5	6	429.5
2013-14	20	45.5	29	43	18	10	36	21.5	94	27	13	13	370
2014-15	22.5	25	30.5	26.5	41	46	42	66	23	21	8	28.5	380
Average	21.25	44	33.09	27.41	30.3	36.87	43.43	64.11	51	32.73	22.78	16.65	423.62
Long Years	19	46	42	29	27	32	41	59	69	49	26	19	458

Data were obtained from the Turkish State Meteorological Service

Table 2. Monthly total precipitation (mm) of Aziziye Location between 2005-2015

Years	MONTHS												
	9	10	11	12	1	2	3	4	5	6	7	8	Total
2005-06	25.8	81.5	6.5	18.7	11.5	4.4	12.2	76.4	46.1	22.8	14.7	8.1	328.7
2006-07	24.2	72.7	27.2	9.6	10.7	18	3.5	103.9	83.3	43.8	40	29.2	466.1
2007-08	1	33.5	82.8	18.7	16.9	4.6	4.5	50.5	57.7	58.7	7.6	19.4	355.9
2008-09	27.4	44.1	31.8	16.7	3.4	17.5	39	43.8	48.9	64.5	45.1	38	420.2
2009-10	40.3	60.3	16.5	9.2	39.9	10.9	86.9	45	72.4	27.9	85.8	13.4	508.5
2010-11	14.2	52.2	0	6	31.6	21.7	11.4	153.8	97.4	54.6	16	32.2	491.1
2011-12	21.1	19.9	3.1	18	17	31	7.6	30.8	82.8	5.8	18.5	1.2	256.8
2012-13	20.7	45.9	34.6	21.4	20.2	40.6	31.2	27.8	27.1	30.2	6	5	310.7
2013-14	13.5	22.1	17.1	3	8	4	38.7	31.2	109.2	7.2	17.7	0	271.7
2014-15	67.8	46.9	11	11.2	21.3	28.3	28.9	69.2	72.2	83.6	9.5	38.4	488.3
Average	25.6	47.91	23.06	13.25	18.05	18.1	26.39	63.24	69.71	39.91	26.09	18.49	389.8
Long Years	20	47	43	31	28	30	38	60	74	47	22	16	456

Data were obtained from the Turkish State Meteorological Service

Table 3. Monthly average temperature for Pasinler Location between 2005-2015 (°C)

Years	MONTHS												
	9	10	11	12	1	2	3	4	5	6	7	8	Total
2005-06	20.4	14.9	1.2	0.5	-15.1	-9.4	0.1	7.1	10.9	16.8	19.4	20.5	7.3
2006-07	14.2	9.3	0.8	-7.8	-12.8	-10.6	-2.1	2.5	12.7	14.9	18.2	18.3	4.8
2007-08	15.7	9.5	0.4	-8.2	-18.2	-14.5	-5.5	7.6	9.5	17.2	19.5	20.1	4.4
2008-09	15.6	9.0	2.4	-9.0	-11.6	-3.8	-0.7	4.6	10.3	14.3	17.3	16.7	5.4
2009-10	12.8	9.6	2.5	-0.6	-4.3	-1.5	3.7	6.3	10.7	16.2	33.0	32.0	10.0
2010-11	32.1	9.8	2.9	-1.0	-7.9	-5.6	-0.5	5.9	10.1	15.0	19.4	19.0	8.3
2011-12	13.9	7.5	-3.8	-11.0	-8.8	-14.3	-6.9	7.2	11.6	16.0	18.8	20.4	4.2
2012-13	15.1	9.7	4.5	-5.1	-8.9	-7.7	-0.1	7.8	11.9	15.0	19.6	19.2	6.8
2013-14	14.3	6.6	2.9	-13.8	-8.7	-6.6	2.7	7.2	11.6	15.7	20.5	21.5	6.2
2014-15	15.5	8.9	0.2	-0.9	-7.3	-6.5	-0.8	5.8	10.7	16.0	21.1	21.4	7.0
Average	17.0	9.5	1.4	-5.7	-10.4	-8.1	-1.0	6.2	11.0	15.7	20.7	20.9	6.4
Long Years	15.5	9.3	3	-2.9	-6.3	-4.7	0	6.8	11.6	15.6	19.7	19.6	7.3

Data were obtained from the Turkish State Meteorological Service

Table 4. Monthly average temperature for Aziziye Location between 2005-2015 (°C)

Years	MONTHS												
	9	10	11	12	1	2	3	4	5	6	7	8	Total
2005-06	13.6	6.3	0.5	-4.5	-13.1	-6.4	0.8	7.0	10.4	3.6	19.0	19.4	4.7
2006-07	13.8	8.2	0.2	-9.0	-13.5	6.3	-1.9	1.6	12.6	14.6	18.0	18.7	5.8
2007-08	15.2	8.6	-1.3	-7.8	-17.8	-15.0	1.5	7.6	7.2	13.7	18.8	19.7	4.2
2008-09	14.9	7.1	-1.8	-4.9	-10.9	-8.2	-0.1	4.4	9.9	14.4	16.8	16.6	4.9
2009-10	12.4	8.5	-1.4	-7.4	-12.1	-3.1	-0.7	4.3	10.0	14.7	17.2	17.1	5.0
2010-11	14.8	9.3	1.7	2.5	-1.5	-14.9	-6.1	2.1	11.2	14.4	19.1	14.5	5.6
2011-12	4.3	4.4	4.0	-11.3	-8.5	-14.9	-6.1	6.7	11.2	15.6	18.7	19.4	3.6
2012-13	14.4	9.2	4.0	-5.4	-9.2	-7.4	-0.5	7.2	11.7	14.8	19.3	19.0	6.4
2013-14	13.5	4.4	4.0	-11.3	-8.5	-14.9	-6.1	6.7	11.2	15.6	19.1	14.4	4.0
2014-15	4.3	9.6	2.3	-13.9	-9.9	-6.9	2.4	7.6	5.9	11.2	19.1	20.0	4.3
Average	12.1	7.6	1.2	-7.3	-10.5	-8.5	-1.7	5.5	10.1	13.3	18.5	17.9	4.8
Long Years	15.2	9.1	2.9	-2.9	-6.2	-4.8	-0.2	6.5	11.1	15.1	19.4	19.3	7.0

Data were obtained from the Turkish State Meteorological Service

Table 5. Soil characteristics of the locations where the trial was conducted

Location	Type	pH	EC	Lime	O.M	P	K
Pasinler	Loamy	7.55	3.20	0.32	1.32	10.11	86
Aziziye	Loamy	7.57	2.60	0.32	1.58	8.35	102

Table 6. Variance analysis table of the trial

Source	DF	Sum of Squares	F Ratio	Prob > F	LSD
Year	9	301243620	109.6	<.0001	237
Location [Year]	10	457185340	149.7	<.0001	334
Replication [Year, Location]	40	14063020	1.2	0.2579	578.7
Variety	6	60244470	32.9	<.0001	198.5
Variety* Year	54	87706160	5.3	<.0001	888.2
Variety* Location [Year]	60	54269660	3.0	<.0001	920

C.V: 15%

Table 7. Yield values of varieties by years (kg ha^{-1})

Years	Ümranhanım	Tatlıcak 97	Mikham	Melez 2001	Doğu 88	Palandöken 97	Alparslan	Years United
2006*	3014 bc	4306 a	4029 ab	3757 a-c	3042 bc	3031 bc	2673 c	**3407 e**
2007ns	4400	4521	5361	4352	4553	4826	4847	**4694 b**
2008*	5263 a	5305 a	500 ab	5061 ab	5468 a	4650 b	4632 b	**5054 a**
2009**	4609 a	4615 a	3334 b	2551 c	3772 b	3645 b	3630 b	**3736 d**
2010**	4582 a	4063 b	2881 c	2619 c	4113 ab	4318 ab	4403 ab	**3854 d**
2011**	5348 a	4222 a	3156 d	3270 cd	3884 b	3767 bc	5436 a	**4155 c**
2012**	2273 ab	2537 b	1914 cd	1676 d	3086 a	2450 b	2241 bc	**2382 f**
2013**	4420 a	3837 ab	2840 de	2289 e	3587 bc	3444 b-d	2905 c-e	**3332 e**
2014**	2749 a	2607 ab	2288 a-c	1644 d	2218 a-c	1956 cd	2091 b-d	**2222 f**
2015**	4730 a	4608 a	2088 c	2456 d	3398 bc	3620 b	3689 b	**3656 d**
Average**	**4189 a**	**4062 a**	**3389 c**	**2967 d**	**3712 b**	**3575 bc**	**3655 b**	**3649**

ns: non significant; **: significant at 0.01; *: significant at 0.05

Table 8. Yield values of locations by years (kg ha^{-1})

Location	2006ns	2007**	2008**	2009**	2010**	2011ns	2012**	2013ns	2014ns	2015**
Aziziye	3164	4098 b	3010 b	1722 b	3239 b	4120	1527 b	3316	2155	2598 b
Pasinler	3650	5291 a	7098 a	5751 a	4469 a	4181	3238 a	3347	2289	4714 a
LSD	808.9	721.4	747.6	424.9	322.4	219.7	375.0	269.2	385.8	377.5

ns: non significant; **: significant at 0.01; *: significant at 0.05

Table 9. Variance analysis table of wheat varieties in terms of years and locations

Source	DF	Sum of Squares	F Ratio	Prob > F	LSD
Year	9	142541280	38.9353	<.0001	422.9
Loc [Year]	10	185192030	45.5269	<.0001	598.1
Tek [Year, Loc]	40	23946460	1.4717	0.0719	1036.2
Variety	2	605180	0.7439	0.4785	231.6
Variety* Year	18	18094320	2.4712	0.0031	732.7
Variety* Loc [Year]	20	11616620	1.4279	0.1341	1036.1

Table 10. Annual average yields of wheat varieties

Location	Doğu 88	Palandöken 97	Alparslan	Average	LSD
Aziziye^{ns}	3307	3338	3059	3234	3188
Pasinler*	4117 ab	3804 b	4250 a	4057	3486
Average	3712	3571	3655	3646	2316

ns: non significant; **: significant at 0.01; *: significant at 0.05

Table 11. Variance analysis table of triticale varieties based on years and locations

Source	DF	Sum of Squares	F Ratio	Prob > F	LSD
Year	9	176302280	111.5738	<.0001	238.1
Loc [Year]	10	290866230	165.6686	<.0001	336.9
Tek [Year, Loc]	40	9783500	1.3931	0.0875	583.5
Variety	3	59635650	113.2222	<.0001	150.7
Variety* Year	27	52011900	10.9720	<.0001	476.5
Variety* Loc [Year]	30	23780110	4.5148	<.0001	673.9

Table 12. Location yields of triticale varieties in terms of yearly averages (kg ha^{-1})

Location	Ümranhanım	Tatlıcak 97	Mikham	Melez 2001	Average	LSD
Ilıca**	3630 a	3510 a	2650 b	2380 c	3017	213.8
Pasinler**	4848 a	4614 b	4129 c	3555 d	4286	218.8
Average**	4189 a	4062 a	3389 b	2967 c	3652	150.7

ns: non significant; **: significant at 0.01: *: significant at 0.05

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