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Research Article

Adaptation of Some Alternative and Winter Barley Varieties to Erzurum Dry Agricultural Conditions

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Abstract

This research was conducted at Atatürk University Plant Production and Research Centre Directorate during the 2017-2018 and 2018-2019 cropping years, and the adaptation of a total of 60 barley varieties (34 alternative and 26 winter varieties) was examined in Erzurum dry agricultural conditions. According to the average of the cropping years, the vegetative period of the varieties varied between 244.8-255.6 days, the grain-filling period was between 27.0-32.3 days, plant height was 83.8-117.8 cm, the number of spikes per m^2 was 375.6-715.0, and the number of grains per spike was 17.8-24.0. Thus, the grain weight was between 34.5-43.4 g, the grain yield was between 225.3-425.1 kg da^{-1}, the biological yield was between 874.1-1283.4 kg da^{-1}, and the harvest index was between 25.7-37.1%. In terms of the characteristics examined, it was determined that the differences between the varieties and the effect of the cropping seasons on these characteristics were significant. Variety × cropping year interaction was significant for the vegetative period, grain yield, biological yield, and harvest index, except for other characteristics. The highest grain yield was obtained from Olgun variety (425.1 kg da^{-1}), followed by Kalaycı-97 (422.2 kg da^{-1}), İnce-04 (418.5 kg da^{-1}) and Çetin 2000 (418.1 kg da^{-1}).

Anahtar Kelimeler: Barley, adaptation, variety, winter cropping, grain yield.

Bazı Alternatif ve Kışlık Arpa Çeşitlerinin Erzurum Kuru Tarım Koşullarına Adaptasyonu

Öz

Bu araştırma 2017-2018 ve 2018-2019 ürün yıllarında yürütülmüş, 34'ü alternatif ve 26'sı kışlık olmak üzere toplam 60 arpa çeşidinin Erzurum kuru tarım koşullarına adaptasyonu incelenmiştir. Ürün yıllarının ortalamasına göre çeşitlerin vejetatif dönemi 244.8-255.6 gün, tane dolum süresi 27.0-32.3 gün, bitki boyu 83.8-117.8 cm, m^2'deki başak sayısı 375.6-715.0, başaktaki tane sayısı 17.8-24.0, 1000 tane ağırlığı 34.5-43.4 g, tane verimi 225.3-425.1 kg da^{-1}, biyoljik verim 874.1-1283.4 kg da^{-1}, hasat indeksi ise %25.7-37.1 arasında değişim göstermiştir. İncelenen karakterler yönünden çeşitler arasındaki farklar ile ürün yıllarının bu karakterler üzerindeki etkisinin önemli olduğu belirlenmiştir. Çeşit x yıl interaksiyonu vejetatif dönem, tane verimi, biyolojik verim ve hasat indeksi için önemli, diğer karakterler için önemsiz çıkmıştır. En yüksek tane verimi Olgun çeşidinden elde edilmiş (425.1 kg da^{-1}), bu çeşidi Kalaycı-97 (422.2 kg da^{-1}), İnce-04 (418.5 kg da^{-1}) ve Çetin 2000 (418.1 kg da^{-1}) çeşitleri takip etmiştir.

Keywords: Arpa, adaptasyon, çeşit, kışlık ekim, tane verimi

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1. Introduction

Barley is a plant belonging to the Hordeum genus of the Poaceae family (El Rabey et al., 2014). Barley is grown and improved for two main purposes in the world an our country, to be used as fodder in animal feeding and as malting (beer) in the industry (Aydoğan et al., 2011). In addition, barley is included in the food industry due to the high content of β-glucan and digestible fiber in its grain, and barley flour is mixed with wheat flour as an additive in some countries. In addition, barley is used in the food industry in the form of biscuits, semolina, barley bread, barley cereal, barley tea, baby food, and crackers (Sipahi et al., 2010).

After wheat, the most produced cool climate grain type barley in the world and Turkey is barley. While the share of barley in cultivated agricultural areas is around 3.4% in the world, this value is 12% for our country and 9.6% for Erzurum (Anonymous, 2020). The cultivation area of barley, which has an important place in the agriculture of our country and Eastern Anatolia, reached its highest values with 3.8 million ha in Turkey in 1998 and 65 thousand ha in Erzurum in 2004. It decreased in the following years and reached 3.2 million ha in Turkey in 2021 decreased to 37 thousand ha in Erzurum (Anonymous, 2021). While barley cultivation areas have decreased in our country and Erzurum, the demand for barley as concentrate has increased, and Turkey has recently become a country that imports barley.

In the Erzurum region, where animal husbandry is an important sector, concentrated feed deficit is an important problem, especially in dry years. 85% of the barley producers in the province are local population, 15% are planting Tokak 157/37 variety, and all barley planting is done between 15 March and 15 May in summer and generally in irrigated areas (Öztürk & Akkuş, 2015). Until the Eastern Anatolia Agricultural Research Institute developed a barley variety named Olgun in 2011, there was no winter barley variety. The increase in the number of winter barley varieties of foreign origin registered in our country in recent years provides an important opportunity to increase the cultivation area and yield of barley in the Eastern Anatolia Region (Öztürk et al., 2018).

Barley grain rich in various mineral substances, is widely used in animal nutrition (Sönmez & Yılmaz, 2000). Barley grain contains approximately 67% carbohydrates, 10% protein, 2% fat, 5% cellulose, and minerals such as calcium, phosphorus, potassium, and vitamins A, E, and B. Since the cellulose content (4-6%) prevents aggregation in the rumen, forage barley is easy to digest and increases milk fat and milk sugar in dairy cows (Sipahi et al., 2010).

Grain is the main product of barley in our country. Apart from the grain, its fresh and dry stems are also economically important. Our production of other grains and barley should be increased regularly to meet the basic food needs of our growing population, concentrate feed of our animals and raw materials in the industry, and be able to export. For this reason, it is important to determine barley varieties with high adaptability and grain yield according to regions. In addition, the adaptations of newly developed varieties that can adapt to changing climatic conditions should be investigated at regular intervals. In this study, which winter adaptation of 60 barley cultivars to Erzurum dry farming conditions was investigated.

2. Material and method

In this research, a total of 60 barley varieties (34 alternative and 26 winter barley varieties) were used as plant material (Table 1), and ammonium sulfate and triple superphosphate were used as fertilizer sources. The research was carried out in the experimental area of Atatürk University Plant Production Application and Research Center Directorate in Erzurum, in the 2017-2018 and 2018-2019 crop years, in dry farming conditions, according to the randomized blocks trial design and in four repetitions. Every two rows in each block, 2.0 m long, 3-5 cm deep, and 20 cm apart in the marker rows, 1 seed at 1 cm intervals (500 seeds/m^2). Sowing was done on 05.10.2017 in the first year and on 24.09.2018 in the second year. 3 kg N da^{-1} and 5 kg da^{-1} P_2O_5 were applied to the blocks, which were turned into a basin, with planting, and when the plants reached the rooting period, they were also fertilized at 3 kg N da^{-1}. Weeds were removed by hand plucking when necessary. 50 cm from the beginning and end of the rows were left as an edge effect, and the plants in the remaining 1 m section were cut with a sickle from a height of 10 cm from the soil level. The plants made into bunches, were left to dry in the field for 3 days and then threshed with the parcel threshing machine.

According to the meteorological data of Erzurum province of the years of the experiment and long years, in the first year of the study (2017-2018), 60.3 mm more precipitation fell than the average of many years, and the annual average temperature was higher than in long years. In the second year (2018-2019), 23.7 mm less precipitation fell and the annual average temperature was higher than in long years.

The soils of the experiment site are in clayey-loamy texture, the organic matter rate of the samples is 1.33%-1.46%, the favorable P_2O_5 rate is 6.3-8.2 kg da^{-1}, the suitable K2O rate is 89.2-96.8 kg da^{-1}, the lime rate is 4.8-5.4%, the pH value is 6.68-It ranged from 6.83. According to this, the soils of the trial site are salt-free, neutral reaction, moderately calcareous, rich in potassium, medium in phosphorus, and poor in organic matter and nitrogen.

Table 1. Barleys used in the experiment and some properties

	Variety name	Institution and date of registration	Spike properties
Winter varieties	Avcı-2002	Tarla Bitkileri Merkez Arş.Ens. Müd.-2002	6 rows
	Aydanhanım	Tarla Bitkileri Merkez Arş.Ens. Müd.-.2002	2 rows
	Balkan 96 (Igri)	Trakya Tarımsal Araştırma Ens.Müd.-1996	2 rows
	Bolayır	Trakya Tarımsal Araştırma Ens.Müd.-2007	2 rows
	Clarica	Ata Tohumculuk İşl.San. ve Tic.A.Ş.-2013	2 rows
	Çetin 2000	Tarla Bitkileri Merkez Arş.Ens. Müd.-2000	6 rows
	Durusu	Anadolu Efes Bir. ve Malt San. A.Ş-2007	2 rows
	Emon	Tarar Un ve Gıda San. Tic. Ltd.Şti.-2014	2 rows
	Escadre	Ata Tohumculuk İşl.San. ve Tic.A.Ş.-2013	6 rows
	Gazda	Tareks Tar.Ür. A. G. İth.İhr.Tic.A.Ş.-2013	2 rows
	Harman	Trakya Tarımsal Araştırma Ens.Müd.-2011	2 rows
	Hasat	Trakya Tarımsal Araştırma Ens.Müd.-2014	2 rows
	Lord	Tareks Tar.Ür. A. G. İth.İhr.Tic.A.Ş.-2011	6 rows
	Manava	Alfa Toh. Tar. Gıd. İnş. Hay. Paz. San. Tic. Ltd. Şti-2014	2 rows
	Meriç	Anadolu Efes Bir. ve Malt San. A.Ş-2005	6 rows
	Olgun	Doğu Anadolu Tarımsal Araştırma Ens. M.-2011	6 rows
	Oliver	Tareks Tar.Ür. A. G. İth.İhr.Tic.A.Ş.-2013	6 rows
	Premium	Ata Tohumculuk İşl.San. ve Tic.A.Ş.-2013	2 rows
	Ramata	Alfa Toh. Tar. Gıd. İnş. Hay. Paz. San. Tic. Ltd. Şti-2015	6 rows
	Scarpia	Marmara Tohum Geliştirme A.Ş.-2015	6 rows
	Seymen	Sarı Tohumculuk San. ve Tic. Ltd.Şti.-2015	2 rows
	Sladoran	Trakya Tarımsal Araştırma Ens.Müd.-1998	2 rows
	Sultan	Tekcan Tohumculuk Gıda ve Tarım Ürünleri San. Tic. Ltd. Şti.-2015	6 rows
	Tokak 157/37	Tarla Bitkileri Merkez Arş.Ens. Müd.-1963	6 rows
	Yıldız	Anadolu Efes Bir. ve Malt San. A.Ş-2007	2 rows
	Zeus	Progen Tohum A.Ş.-2014	6 rows
Alternative varieties	Akar	Tarla Bitkileri Merkez Arş.Ens. Müd.-2012	2 rows
	Akdane	Anadolu Efes Bir. ve Malt San. A.Ş-2011	2 rows
	Arcanda	Progen Tohum A.Ş.-11.04.2014	2 rows
	Atılır	Anadolu Efes Bir. ve Malt San. A.Ş-.2005	2 rows
	Başgül	Anadolu Efes Bir. ve Malt San. A.Ş-2003	2 rows
	Beyşehir	Bahri Dağdaş Uluslararası Tar. Araş. Ens. M.-1998	2 rows
	Burakbey	Tarla Bitkileri Merkez Arş.Ens. Müd.-2013	2 rows
	Bülbül 89	Tarla Bitkileri Merkez Arş.Ens. Müd.-1989	2 rows
	Cervoise	Ata Tohumculuk İşl.San. ve Tic.A.Ş.-2011	6 rows
	Cumhuriyet 50	Geçit Kuşağı Tarımsal Arşt.Enst.Müd.-1973	2 rows
	Çıldır 02	Geçit Kuşağı Tarımsal Arşt.Enst.Müd.-2002	2 rows
	Çumra 2001	Anadolu Efes Bir. ve Malt San. A.Ş-2001	2 rows
	Efes 98	Anadolu Efes Bir. ve Malt San. A.Ş-1998	2 rows
	Erciyes	Anadolu Efes Bir. ve Malt San. A.Ş-2006	2 rows
	Erginel 90	Geçit Kuşağı Tarımsal Arşt.Enst.Müd.-1990	6 rows
	İnce-04	Geçit Kuşağı Tarımsal Arşt.Enst.Müd.-2004	2 rows
	Kalaycı-97	Geçit Kuşağı Tarımsal Arşt.Enst.Müd.-1997	2 rows
	Karatay 94	Bahri Dağdaş Uluslararası Tar. Araş. Ens. M.-1996	2 rows
	Keser	Geçit Kuşağı Tarımsal Arşt.Enst.Müd.-2007	2 rows
	Kıral-97	Bahri Dağdaş Uluslararası Tar. Araş. Ens. M.-1997	6 rows
	Konevi	Bahri Dağdaş Uluslararası Tar. Araş. Ens. M.-1998	2 rows
	Larende	Bahri Dağdaş Uluslararası Tar. Araş. Ens. M.-2006	2 rows
	Martı	Trakya Tarımsal Araştırma Ens.Müd.-2009	6 rows
	Orza 96	Tarla Bitkileri Merkez Arş.Ens. Müd.-1996	2 rows
	Özdemir-05	Geçit Kuşağı Tarımsal Arşt.Enst.Müd.-2005	2 rows
	Sur-93	GAP Uluslararası Tarımsal Araş. ve Eğitim Merk. Müd./Diyarbakır-2002	2 rows
	Şahin-91	GAP Uluslararası Tarımsal Araş. ve Eğitim Merk. Müd./Diyarbakır-1991	2 rows
	Tarm-92	Tarla Bitkileri Merkez Arş.Ens. Müd.-1992	2 rows
	Toprak	Anadolu Efes Bir. ve Malt San. A.Ş-2011	2 rows
	Ünver	Geçit Kuşağı Tarımsal Arşt.Enst.Müd.-2013	2 rows
	Yalın	Tarla Bitkileri Merkez Arş.Ens. Müd.-2014	2 rows
	Yerçil-147	Geçit Kuşağı Tarımsal Arşt.Enst.Müd.-1976	2 rows
	Yesevi 93	Tarla Bitkileri Merkez Arş.Ens. Müd.-1993	2 rows
	Zeynel Ağa	Tarla Bitkileri Merkez Arş.Ens. Müd.-2003	2 rows

3. Results and Discussion

It was determined that the differences between barley varieties in terms of vegetative period, grain filling time, plant height, the number of spikes per m^2, the number of grains per spike, 1000 grain weight, grain yield, biological yield, and harvest index, and the effect of crop years on these characters were determined. Cultivar x year interaction was significant for the vegetative period, grain yield, biological yield, and harvest index, but insignificant for other characters (Tables 2, 3, 4).

3.1. Vegetative period, grain filling period, and plant height

The vegetative period, grain filling time, and plant height values of barley cultivars and variance analysis results of these characters are given in Table 2. According to the average of the

varieties, the vegetative periods of the 2017-2018 and 2018-2019 crop years were 254.2 and 247.3 days, respectively; Grain filling times were 30.7 and 28.6 days, and plant heights were 107.8 and 97.84 cm (Table 2). In the second crop year, June, when the spike took place, was hotter and drier than the first year. This decrease in the vegetative period may have resulted from this. The second crop year was hotter and drier than the first year. This decrease in grain filling time and plant height may have resulted from this.

The vegetative period of the cultivars changed between 244.8-255.6 days according to the average of the years and the shortest vegetative period was observed in the Avcı-2002 cultivar. This cultivar was followed by Karatay-94 (245.1 days), Kalaycı-97 (245.1 days), and Ramata (245.0 days), and the difference between them was insignificant. Sultan cultivar had the longest vegetative period, followed by Clarica (255.4 days), Konevi (255.0 days), and Sladoran (255.0 days). Since the vegetative period of the varieties varies according to the years, the year x variety interaction was found to be important (Table 2).

Table 2. Vegetative period, grain filling time and plant height of barley cultivars and variance analysis results of these characters

Variety name	Vegetative period (day)			Grain filling time (day)			Plant height (cm)		
	2017-2018	2018-2019	Birleşik	2017-2018	2018-2019	Birleşik	2017-2018	2018-2019	Birleşik
Avcı-2002	249.0	240.5	244.8	29.3	27.3	28.3	100.0	91.1	95.5
Aydanhanım	250.8	242.8	246.8	28.3	26.3	27.3	119.0	103.5	111.2
Balkan 96	247.8	244.5	246.1	29.3	27.3	28.3	102.3	94.3	98.3
Bolayır	256.3	247.3	251.8	31.0	28.8	29.9	113.4	103.7	108.5
Clarica	259.3	251.5	255.4	32.5	30.5	31.5	101.3	87.9	94.7
Çetin 2000	258.3	251.8	255.0	30.3	28.5	29.4	115.3	104.4	109.8
Durusu	253.8	247.3	250.5	31.8	29.3	30.5	105.7	97.9	101.8
Emon	251.3	244.3	247.8	29.3	27.3	28.3	108.4	96.8	102.6
Escadre	257.5	251.5	254.5	32.3	30.3	31.3	114.6	106.5	110.5
Gazda	256.8	250.5	253.6	30.3	28.3	29.3	95.3	90.0	92.6
Harman	255.3	247.5	251.4	31.3	29.5	30.4	113.7	104.6	109.2
Hasat	252.3	244.5	248.4	31.3	29.3	30.3	104.0	100.3	102.2
Lord	257.8	251.3	254.5	29.5	27.5	28.5	110.9	98.9	104.9
Manava	256.3	247.5	251.9	30.0	28.0	29.0	110.9	99.2	105.0
Meriç	255.3	247.5	251.4	32.8	30.5	31.6	105.5	98.8	102.1
Olgun	254.3	247.3	250.8	32.3	29.8	31.0	123.6	110.0	116.8
Oliver	251.8	246.5	249.1	32.3	30.3	31.3	106.1	91.0	98.5
Premium	251.8	242.5	247.1	32.5	29.0	30.8	100.8	95.7	98.2
Ramata	247.8	243.3	245.5	30.8	27.8	29.3	100.7	92.6	96.7
Scarpia	250.8	245.3	248.0	28.8	26.8	27.8	121.5	103.6	112.5
Seymen	252.0	248.8	250.4	28.5	27.0	27.8	84.8	82.9	83.8
Sladoran	258.3	251.8	255.0	30.8	28.5	29.6	126.3	106.5	116.4
Sultan	259.3	252.0	255.6	30.8	29.5	30.1	95.8	93.5	94.6
Tokak 157/37	253.3	247.0	250.4	32.3	28.8	30.5	112.8	97.0	104.9
Yıldız	252.0	247.8	249.9	28.5	26.5	27.5	97.9	95.6	96.7
Zeus	251.5	245.8	248.6	28.8	27.5	28.1	107.6	103.9	105.7
Akar	255.0	247.5	251.3	32.8	29.8	31.3	123.4	112.2	117.8
Akdane	253.8	246.8	250.3	31.0	28.8	29.9	110.9	103.0	106.9
Arcanda	255.0	246.8	250.9	33.0	30.3	31.6	99.1	96.0	97.6
Atılır	253.8	245.3	249.5	30.3	29.0	29.6	106.5	96.8	101.6
Başgül	255.0	247.0	251.0	32.3	29.8	31.0	104.0	91.9	98.0
Beyşehir	256.8	248.8	252.8	32.5	29.3	30.9	98.5	93.6	96.0
Burakbey	255.8	248.0	251.9	29.8	27.5	28.6	110.6	101.9	106.3
Bülbül 89	254.3	247.8	251.0	29.3	27.0	28.1	120.9	99.8	110.3
Cervoise	256.3	250.3	253.3	28.3	27.3	27.8	98.5	89.0	93.7
Cumhuriyet 50	255.8	249.3	252.5	30.5	29.0	29.8	115.9	104.0	109.9
Çıldır 02	257.0	248.8	252.9	33.3	30.8	32.0	98.1	92.8	95.4
Çumra 2001	255.3	247.0	251.1	32.8	30.0	31.4	114.7	105.7	110.2
Efes 98	252.3	245.3	248.8	30.8	28.0	29.4	119.6	101.6	110.6
Erciyes	253.0	247.0	250.0	28.3	26.8	27.5	98.4	98.0	98.2
Erginel 90	256.8	248.8	252.8	28.8	27.5	28.1	111.9	95.8	103.8
İnce-04	250.8	242.5	246.6	32.0	29.8	30.9	104.6	92.8	98.7
Kalaycı-97	248.8	241.5	245.1	32.8	30.5	31.6	91.4	90.2	90.8
Karatay 94	248.8	242.0	245.1	32.8	29.8	31.3	103.4	100.3	101.8
Keser	250.8	245.0	247.9	30.0	27.8	28.9	110.9	96.9	103.9
Kıral-97	251.8	246.8	249.3	28.8	26.5	27.6	108.7	97.1	102.9
Konevi	259.3	250.8	255.0	27.8	26.5	27.1	117.0	96.9	106.9
Larende	257.3	249.8	253.5	28.8	27.8	28.3	107.6	92.2	99.9
Martı	257.3	249.8	253.5	32.8	30.5	31.6	110.9	98.6	104.7
Orza 96	251.3	244.5	247.9	30.8	28.8	29.8	117.7	108.5	113.1
Özdemir-05	253.3	245.5	249.4	30.5	27.8	29.1	111.2	100.0	105.6
Sur-93	254.8	247.5	251.1	32.8	31.5	32.1	94.1	82.6	88.4
Şahin-91	255.5	248.0	251.8	32.8	31.8	32.3	107.6	95.8	101.7
Tarm-92	256.8	249.0	252.9	32.0	28.8	30.4	110.7	100.4	105.5
Toprak	253.3	246.3	249.8	32.8	30.5	31.6	105.0	95.1	100.0
Ünver	256.8	250.5	253.6	32.8	30.5	31.6	105.1	92.6	98.8
Yalın	257.8	251.8	254.8	29.5	27.3	28.4	107.6	95.5	101.5
Yerçil-147	256.0	249.0	252.5	30.0	27.5	28.8	116.2	105.0	110.6
Yesevi 93	253.8	247.8	250.8	28.8	26.3	27.5	114.6	105.1	109.8
Zeynel Ağa	251.3	245.3	248.3	27.8	26.3	27.0	98.2	93.8	96.0
Average	254.2	247.3	250.7	30.7	28.6	29.7	107.8	97.8	102.8
F value (Year)	-	-	4304.7**	-	-	938.4**	-	-	166.4**
F value (Variety)	50.9**	15.7**	47.7**	38.3 **	9.6**	32.4**	4.3**	2.0**	5.6**

F value (Block)	4.0**	1.3	3.9**	7.2 **	1.4	5.3**	0.7	0.6	1.1
F value (YxV)	-	-	2.5**	-	-	1.3	-	-	0.7
CV (%)	0.3	0.6	0.5	1.8	3.3	2.6	7.7	8.9	8.3
LSD (0.05) (Y)	-	-	0.2	-	-	1.4	-	-	1.5
LSD (0.05) (V)	1.2	2.0	1.1	0.8	1.3	0.8	11.6	12.1	8.4
LSD (0.05) (YxV)	-	-	1.6	-	-	1.1	-	-	11.8

F values with * are 0.05, F values with ** are 0.01 degrees of significance.

When the years are evaluated separately, the vegetative period in the 2017-2018 crop year varied between 247.8-259.3 days, while Balkan 96 and Ramata varieties had the shortest vegetative period, followed by Karatay 94 (248.3 days) and Kalaycı-97 (248.8 days). The difference was insignificant. While Konevi, Sultan, and Clarica cultivars had the longest vegetative period, these cultivars were followed by Sladoran (258.3 days) and Çetin 2000 (258.3 days) and the difference between them was insignificant. In the 2018-2019 crop year, the vegetative period varied between 240.5-252.0 days, while Avcı-2002 had the shortest vegetative period, followed by Kalaycı-97 (241.5 days) and Karatay 94 (242.0 days), and the difference between them was insignificant. While the Sultan variety had the longest vegetative period, this variety was followed by Yalın (251.8 days), Sladoran (251.8 days), and Çetin 2000 (251.8 days) varieties, Sultan variety with the longest vegetative period, and Cervoise variety with 250.3 days vegetative period. Difference between them was insignificant. Since the vegetative period of the varieties varies according to the years, the year x variety interaction was found to be significant ($P<0.01$) (Table 2). When the years are evaluated separately, the vegetative period in the 2017-2018 crop year varied between 247.8-259.3 days, while Balkan 96 and Ramata varieties had the shortest vegetative period, followed by Karatay 94 (248.3 days) and Kalaycı-97 (248.8 days). The difference was insignificant. While Konevi, Sultan and Clarica cultivars had the longest vegetative period, these cultivars were followed by Sladoran (258.3 days) and Çetin 2000 (258.3 days) and the difference between them was insignificant. In the 2018-2019 crop year, the vegetative period varied between 240.5-252.0 days, while Avcı-2002 had the shortest vegetative period, followed by Kalaycı-97 (241.5 days) and Karatay 94 (242.0 days), and the difference between them was insignificant. While the Sultan variety had the longest vegetative period, this variety was followed by Yalın (251.8 days), Sladoran (251.8 days), and Çetin 2000 (251.8 days). Closely to our findings, Öztürk et al. (2018) determined the vegetative period as 257.4 and 258.7 days in two barley cultivars planted in Erzurum conditions in winter. Kandemir (2004) reported that the vegetative period in barley varieties in Tokat conditions changed between 146.7-167.0 days in the first year and 152.3-168.0 days in the second year.

According to the averag years, the grain filling time of the varieties varied between 27.0-32.3 days, Zeynel Ağa had the shortest grain filling time and Şahin-91 had the longest grain filling time. Konevi (27.1 days), Aydanhanım (27.3 days) and Yesevi 93 (27.5 days) varieties have a short grain filling time; Sur-93 (32.1 days), Çıldır-02 (32.0 days) and Ünver (31.6 days) cultivars drew attention as other cultivars with a long grain filling time. Öztürk et al. (2018) determined the grain filling time as 31.0 and 31.7 days in two cultivars planted in winter. Significant differences were determined in terms of grain filling time between barley varieties planted in summer under Erzurum irrigated farming conditions, and Öztürk et al. (2018), 34.5-40.3 days by Çağlar et al. (2009) reported grain filling times varying between 32.3-33.3 days.

According to the average of the years, the plant height of the cultivars varied between 83.8-117.8 cm. Akar variety had the highest plant height, followed by the Olgun (116.8 cm), Sladoran (116.4 cm), and Orza 96 (113.1 cm) varieties. The difference between Akar cultivar with the longest plant height and Çetin 2000 cultivar with 109.8 cm plant height was insignificant. The hortest plant height was measured in the Seymen variety, followed by the Sur-93 (88.4 cm) and Kalaycı-97 (90.8 cm) varieties and the difference between them was insignificant. Kendal et al. (2010), 90.0-128.1 cm, 73.6-89.7 cm by Çöken and Akman (2016), and 74.8-104.1 cm by İmamoğlu and Yılmaz (2012). Dogan et al. (2014) reported that plant height is a morphological feature that indirectly affects yield, and although it is a character with high heritability, it is affected by the environment.

3.2. Number of spikes per square meter, number of grains per spike, and 1000-grain weight

The number of ears per square meter, number of grains per ear, and 1000 grain weight values of barley varieties and the variance analysis results of these characters are presented in Table 3. According to the average of the varieties, the number of spikes per square meter was 593.8 and 541.7, the number of grains per spike was 22.5 and 19.1, and the weight of 1000 grains was 40.5 g and 37.6 g, respectively, in the crop years 2017-2018 and 2018-2019 (Table 3). (Sönmez et al., 1996) reported in their study that low rainfall and short growth period caused a decrease in the number of ears per m^2. The number of grains per spike depends on the total and fertile spikelet number per spike, the number of flowers in each spikelet, and their grain setting ratio. Grain-setting rates are also affected by environmental factors (Kaydan & Yağmur, 2007). 1000 grain weight is a genetically managed trait and varies according to the variety and environmental conditions (Çölkesen et al., 1994). The precipitation, which was 285.6 mm in the first year, decreased to 170.9 mm in the second year. The reason for the decrease in the number of ears per m^2, the number of grains per spike, and the weight of 1000 grains may be due to the drier second year.

According to the average of the years, the number of spikes per m^2 of the cultivars varied between 375.6-715.0. While the Atılır variety had the highest number of spikes in m^2, this variety was followed by Ramata (670.6), Akar (650.0), and Gazda (636.3). It was determined that the number of ears per m^2 was the lowest in the Zeus variety, and Ünver (388.8), Zeynel Ağa (442.5) and Bolayır (451.9) varieties took the last place in terms of the number of ears per m^2 (Table 3). (Akdeniz et al., 2004), in their research in Van conditions, reported that the number of ears per m^2 for barley varieties varied between 417.5 and 551.5. Budakli et al. (2005) determined the number of ears per m^2 in barley varieties between 642.3-881.4 in Bursa conditions. Sirat and Sezer (2009) determined the number of ears of barley varieties per m^2 between 394.6-547.5 in the conditions of Bafra Plain and drew attention to the fact that the highest number of ears per m^2

was obtained from the Zeynel Ağa variety.In another study carried out in Bursa conditions, the number of ears per m^2 in barley cultivars varied between 468.8 and 988.0, the lowest number of ears per m^2 was found in Vamıkhoca 98 cultivar, and the highest number of 15 in line (İmamoğlu & Yılmaz, 2012). Karahan and Sabancı (2010) determined that the number of ears per m^2 in barley varieties varied between 378-661, and this value was 643 and 451 for Diyarbakır and Ceylanpınar locations, respectively. Researchers pointed out that the Şerifehanım-98 cultivar, which has the highest number of spikes in the Diyarbakır location, ranks lower in the Ceylanpınar location, and that tillering in cultivars and the number of spikes per m^2 may vary depending on the environmen

Table 3. The results of the variance analysis of barley varieties with the number of ears per m^2, the number of grains per ear, and 1000-grain weights.

Variety nane	Number of ears per m^2			Number of grains per ear			1000-grain weights (g)		
	2017-2018	2018-2019	Birleşik	2017-2018	2018-2019	Birleşik	2017-2018	2018-2019	Birleşik
Avcı-2002	563.8	522.5	543.1	22.8	20.0	21.4	38.4	35.5	36.9
Aydanhanım	612.5	565.0	588.8	23.8	20.8	22.3	41.2	38.1	39.6
Balkan 96	547.5	487.5	517.5	22.5	19.0	20.8	42.0	38.6	40.3
Bolayır	478.8	425.0	451.9	25.5	22.5	24.0	41.4	37.2	39.3
Clarica	645.0	590.0	617.5	22.3	18.3	20.3	38.3	35.3	36.8
Çetin 2000	636.3	586.3	611.3	25.3	21.3	23.3	38.9	35.9	37.4
Durusu	615.0	553.8	584.4	24.5	20.5	22.5	42.3	38.4	40.3
Emon	635.0	598.8	616.9	21.5	18.0	19.8	43.4	39.5	41.4
Escadre	645.0	592.5	618.8	22.3	18.5	20.4	37.6	35.1	36.4
Gazda	663.8	608.8	636.3	23.5	19.3	21.4	43.8	39.8	41.8
Harman	497.5	492.5	495.0	21.5	17.8	19.6	41.1	38.4	39.7
Hasat	655.0	596.3	625.6	23.3	19.5	21.4	41.5	38.8	40.2
Lord	608.8	566.3	587.5	24.5	19.5	22.0	37.9	35.6	36.8
Manava	565.0	515.0	540.0	22.5	18.3	20.4	41.2	38.8	40.0
Meriç	623.8	566.3	595.0	24.8	20.8	22.8	38.8	36.0	37.4
Olgun	623.8	592.5	608.1	26.0	21.0	23.5	38.3	35.7	37.0
Oliver	660.0	578.8	619.4	22.0	18.5	20.3	38.4	36.6	37.5
Premium	543.8	528.8	536.3	22.5	18.3	20.4	43.7	38.7	41.2
Ramata	702.5	638.8	670.6	20.3	17.5	18.9	38.0	36.1	37.1
Scarpia	677.5	591.3	634.4	22.5	19.0	20.8	38.6	37.2	37.8
Seymen	555.0	493.8	524.4	23.8	20.5	22.1	42.9	39.6	41.3
Sladoran	595.0	555.0	575.0	22.5	19.0	20.8	42.2	38.4	40.3
Sultan	655.0	553.8	604.4	23.3	18.3	20.8	38.0	37.3	37.7
Tokak 157/37	516.3	492.5	504.4	18.8	16.8	17.8	43.2	40.6	41.9
Yıldız	595.0	498.8	546.9	22.5	19.3	20.9	42.3	40.5	41.4
Zeus	382.5	368.8	375.6	19.8	17.5	18.6	39.8	37.2	38.5
Akar	690.0	610.0	650.0	22.3	19.8	21.0	39.7	37.1	38.4
Akdane	537.5	510.0	523.8	23.8	20.5	22.1	39.9	36.0	38.0
Arcanda	618.8	601.3	610.0	22.0	20.3	21.1	36.2	32.8	34.5
Atılır	742.5	687.5	715.0	24.8	21.0	22.9	34.9	34.1	34.5
Başgül	621.3	566.3	593.8	23.5	20.0	21.8	39.8	36.4	38.1
Beyşehir	633.8	562.5	598.1	20.5	17.8	19.1	41.8	37.4	39.6
Burakbey	652.5	546.3	599.4	22.3	19.5	20.9	38.7	35.4	37.1
Bülbül 89	631.3	565.0	598.1	22.8	19.0	20.9	41.5	37.9	39.7
Cervoise	483.8	457.5	470.6	22.0	19.5	20.8	41.3	37.5	39.4
Cumhuriyet 50	648.8	558.8	603.8	24.3	21.0	22.6	40.6	37.2	38.9
Çıldır 02	535.0	495.0	515.0	24.8	20.0	22.4	41.7	38.7	40.2
Çumra 2001	487.5	505.0	496.3	23.8	19.5	21.6	41.1	37.7	39.4
Efes 98	645.0	580.0	612.5	22.8	19.0	20.9	42.3	38.2	40.2
Erciyes	610.0	521.3	565.6	22.0	18.3	20.1	41.9	37.9	39.9
Erginel 90	607.5	585.0	596.3	21.0	18.8	19.9	38.3	36.6	37.4
İnce-04	657.5	582.5	620.0	23.0	18.8	20.9	42.8	39.7	41.2
Kalaycı-97	640.0	572.5	606.3	23.5	19.3	21.4	41.7	38.9	40.3
Karatay 94	590.0	538.8	564.4	24.8	21.0	22.9	41.6	37.9	39.8
Keser	583.8	481.3	532.5	24.5	20.0	22.3	39.8	36.0	37.9
Kıral-97	501.3	478.8	490.0	22.0	19.3	20.6	38.6	36.7	37.8
Konevi	615.0	550.0	582.5	23.5	19.8	21.6	41.8	38.8	40.3
Larende	532.5	495.0	513.8	25.8	20.8	23.3	41.1	37.8	39.5
Martı	587.5	532.5	560.0	22.5	19.0	20.8	37.8	35.5	36.7
Orza 96	562.5	503.8	533.1	19.8	17.3	18.5	39.8	37.4	38.6
Özdemir-05	627.5	583.8	605.6	20.3	17.8	19.0	45.0	41.9	43.4
Sur-93	623.8	571.3	597.5	20.3	16.5	18.4	41.4	38.6	40.0
Şahin-91	558.8	505.0	531.9	20.3	17.3	18.8	41.4	39.0	40.2
Tarm-92	652.5	601.3	626.9	19.5	16.3	17.9	42.5	40.0	41.2
Toprak	482.5	477.5	480.0	19.8	17.5	18.6	42.7	40.1	41.4
Ünver	406.3	361.3	383.8	21.5	17.8	19.6	43.6	41.5	42.6
Yalın	611.3	557.5	584.4	21.5	18.8	20.1	38.6	36.8	37.7
Yerçil-147	641.3	590.0	615.6	19.8	16.8	18.3	38.9	37.2	38.1
Yesevi 93	640.0	592.5	616.3	20.8	17.8	19.3	40.0	37.9	39.0
Zeynel Ağa	470.0	415.0	442.5	22.5	18.5	20.5	37.0	35.2	36.1
Average	593.8	541.7	567.7	22.5	19.1	20.8	40.5	37.6	39.0

F value (Year)	-	-	142.9**	-	-	1319.9**	-	-	748.6**
F value (Variety)	8.7**	6.5**	14.8**	11.1**	6.3**	16.3**	22.2**	6.8**	21.8**
F value (Block)	2.9*	3.2*	6.1**	4.2**	1.6	5.3**	0.9	0.2	0.5
F value (YxV)	-	-	0.5	-	-	1.1	-	-	1.1
CV (%)	8.1	8.8	8.4	4.6	5.6	5.1	2.2	3.6	3.0
LSD (0.05) (Y)	-	-	8.6	-	-	0.2	-	-	0.2
LSD (0.05) (V)	67.3	66.5	47.0	1.4	1.5	1.0	1.3	1.9	1.1
LSD (0.05) (YxV)	-	-	66.4	-	-	1.5	-	-	1.6

F values with * are 0.05, F values with ** are 0.01 degrees of significance.

The number of grains per spike of barley cultivars varied between 17.8-24.0 and the highest grain count per spike was determined to be in Bolayır, Olgun (23.5), Larende (23.3) and Çetin 2000 (23.3). The lowest number of grains per spike was detected in Tokak 157/37 cultivars, followed by Tarm-92 (17.9), Yerçil-147 (18.3), and Sur-93 (18.4) (Table 3). The number of grains per ear in barley cultivars was determined between 20.0-46.3 by İmamoğlu and Yılmaz (2012), and 16.3-20.2 by Kaydan and Yağmur (2007). The number of grains per spike depends on the number of fertile spikelets and the grain attachment ratio of the spikelets, and these factors may vary according to genotype and environmental factors.

According to the average of the years, 1000 grain weights of barley varieties varied between 34.5-43.4 g. Özdemir-05 variety had the highest 1000-grain weight, followed by Ünver (42.6 g), Tokak 157/37 (41.9 g), and Gazda (41.8 g). The lowest 1000-grain weight was determined in the Arcanda variety, followed by Atılır (34.5 g), Zeynel Ağa (36.1 g), and Escadre (36.4 g) varieties (Table 3). 1000 grain weight is a genetically managed trait and varies according to the variety and environmental conditions (Çölkesen et al., 1994). Akdeniz et al. (2004) 40.69-51.74 g in Van conditions, and Aydogan et al. (2011) reported 1000 grain weights varying between 38.30-43.17 g in Konya conditions.

3.3. Grain yield, biological yield, and harvest index

The grain yield, biological yield, and harvest index values of barley cultivars and the variance analysis results of these characters are shown in Table 4. Grain yield was 423.7 and 309.2 kg da^{-1}, the biological yield was 1205.0 and 976.4 kg da^{-1}, and the harvest index was 34.9% and 32.0%, respectively, in the first and second crop years of the cultivars. The number of ears per m^2, the number of grains per spike, and 1000 grain weight are the factors affecting the yield. The decrease in these elements causes a decrease in grain yield. The factors affecting the biological yield are the plant height and the number of spikes per m^2. The decrease in plant height and number of ears per m^2 also causes a decrease in biological yield. (Kırtok, 1984) report that the harvest index can be affected by environmental conditions, while Singh and Stoscopef, (1971) report that there is a significant relationship between year and variety in terms of harvest index.

According to the years' average, the varieties' grain yields varied between varied between 225.3-425.1 kg da^{-1}. Olgun variety had the highest grain yield, followed by Kalaycı-97 (422.2 kg da^{-1}), İnce-04 (418.5 kg da^{-1}) and Çetin 2000 (418.1 kg da^{-1}) varieties. The difference between the Olgun variety with the highest grain yield and the Scarpia variety with 400.1 kg/da grain yield was insignificant. The lowest grain yield was determined in the Zeus variety, followed by Zeynel Ağa (263.7 kg da^{-1}), Ünver (268.8 kg da^{-1}), and Toprak (283.2 kg da^{-1}). Since the grain yields of the cultivars changed according to the years, the year x cultivar was found to be significant (P<0.01) (Table 4). When the years are evaluated separately, the grain yields of the cultivars ranged from 275.3 to 501.90 kg da^{-1} in the 2017-2018 crop year, while the Kalaycı-97 cultivar had the highest grain yield; This cultivar was followed by Efes 98 (495.9 kg da^{-1}), Olgun (495.8 kg da^{-1}) and İnce-04 (490.6 kg da^{-1}) and Kalaycı-97 cultivar with the highest grain yield and 468.2 kg da^{-1} grain yield. The difference with the Scarpia cultivar was insignificant. While Zeus variety has the lowest grain yield; This variety was followed by Ünver (304.5 kg da^{-1}), Toprak (308.5 kg da^{-1}), and Zeynel Ağa (312.0 kg da^{-1}). Grain yields of the cultivars ranged from 175.2 to 373.6 kg da^{-1} in the 2018-2019 crop year, while the Gazda cultivar had the highest grain yield; This cultivar was followed by Arcanda (370.1 kg da^{-1}), Harvest (360.9 kg da^{-1}), and Çetin 2000 (358.1 kg da^{-1}) cultivars. While the Zeus variety has the lowest grain yield; Zeynel Ağa (215.5 kg da^{-1}), Ünver (233.2 kg da^{-1}), and Toprak (257.9 kg da^{-1}) followed this variety. It is noteworthy that the grain yields obtained in this study were significantly higher than the grain yields obtained in previous studies in Erzurum irrigated farming conditions (Akkaya & Akten, 1990; Öztürk et al., 2001; Çağlar et al., 2009). Even if the varieties used in the research are different, these results clearly show the superiority of winter planting in dry farming conditions in terms of yield. Karahan and Sabancı (2010) reported that the grain yield of barley cultivars varied between 388-487 kg/da in Diyarbakır conditions and the Vamıkhoca-98 cultivar had the highest grain yield. Kızılgeçi et al. (2016) determined that grain yield in barley genotypes ranged from 324.3 kg da^{-1} to 445.8 kg da^{-1}.

According to the average of the years, the biological yields of the cultivars varied between 874.1-1283.4 kg da^{-1}. Gazda variety had the highest biological yield, followed by Durusu (1237.3 kg da^{-1}), Efes-98 (1214.4 kg da^{-1}), and Çetin 2000 (1210.2 kg da^{-1}) varieties. The lowest biological yield was determined in the Zeus cultivar, and Zeynel Ağa (887.7 kg da^{-1}), Ünver (920.4 kg da^{-1}), and Orza 96 (939.8 kg da^{-1}) cultivars took the last place in terms of biological yield (Table 4). Since the biological yields of the cultivars vary according to the years, the year x cultivar interaction was found to be significant (P<0.01) (Table 4). When the years are evaluated separately, the biological yields of the varieties in the 2017-2018 crop year ranged between 1019.0-1330.6 kg da^{-1}, while the Gazda variety had the highest biological yield; this variety was followed by Durusu (1325.9 kg da^{-1}), Kalaycı-97 (1320.3 kg da^{-1}) and Efes 98 (1308.2 kg da^{-1}). While Cervoise variety has the lowest biological efficiency; This cultivar was followed by Ünver (1034.8 kg da^{-1}), Orza 96 (1043.9 kg da^{-1}), and Zeus (1047.9 kg da^{-1}), and the difference between the Cervoise cultivar with the lowest biological yield and Akdane cultivar with 1073.9 kg da^{-1} biological yield. was found to be insignificant. In the 2018-2019 crop year, the biological yields of the varieties ranged from 700.3 to 1236.2 kg da^{-1}, while the Gazda variety had the highest biological yield; this cultivar was followed by Durusu (1148.8 kg da^{-1}), Atılır (1128.9 kg da^{-1}) and Efes 98

(1120.7 kg da^{-1}) cultivars. While the Zeus variety has the lowest biological yield; Zeynel Ağa (727.4 kg da^{-1}), Ünver (806.1 kg da^{-1}), and Orza 96 (835.6 kg da^{-1}) followed this variety. Çöken and Akman (2016) determined the biological yield of barley varieties between 749.4-1366.1 kg da^{-1} in Isparta conditions, they obtained the highest biological yield from Akar and the lowest biological yield from the İnce-04 variety.

The harvest index of barley cultivars varied between 25.7-37.1% as the average of the crop years. The highest harvest index was determined in the Olgun variety, followed by Meriç (36.8%), Özdemir-05 (36.7%), Yalın (36.1%), and Scarpia (35.8%). The lowest harvest index was calculated for the Zeus cultivar, followed by Toprak (29.1%), Ünver (29.2%), and Zeynel Ağa (29.7%) cultivars. Since the harvest indices of the cultivars changed according to the years, the year x cultivar interaction was found to be significant (P<0.01) (Table 4).

Table 4. The results of the variance analysis of barley varieties with the number of ears per m^2, the number of grains per ear, and 1000-grain weights

Variety nane	Number of ears per m^2			Number of grains per ear			1000-grain weights (g)		
	2017-2018	2018-2019	Birleşik	2017-2018	2018-2019	Birleşik	2017-2018	2018-2019	Birleşik
Avcı-2002	563.8	522.5	543.1	22.8	20.0	21.4	38.4	35.5	36.9
Aydanhanım	612.5	565.0	588.8	23.8	20.8	22.3	41.2	38.1	39.6
Balkan 96	547.5	487.5	517.5	22.5	19.0	20.8	42.0	38.6	40.3
Bolayır	478.8	425.0	451.9	25.5	22.5	24.0	41.4	37.2	39.3
Clarica	645.0	590.0	617.5	22.3	18.3	20.3	38.3	35.3	36.8
Çetin 2000	636.3	586.3	611.3	25.3	21.3	23.3	38.9	35.9	37.4
Durusu	615.0	553.8	584.4	24.5	20.5	22.5	42.3	38.4	40.3
Emon	635.0	598.8	616.9	21.5	18.0	19.8	43.4	39.5	41.4
Escadre	645.0	592.5	618.8	22.3	18.5	20.4	37.6	35.1	36.4
Gazda	663.8	608.8	636.3	23.5	19.3	21.4	43.8	39.8	41.8
Harman	497.5	492.5	495.0	21.5	17.8	19.6	41.1	38.4	39.7
Hasat	655.0	596.3	625.6	23.3	19.5	21.4	41.5	38.8	40.2
Lord	608.8	566.3	587.5	24.5	19.5	22.0	37.9	35.6	36.8
Manava	565.0	515.0	540.0	22.5	18.3	20.4	41.2	38.8	40.0
Meriç	623.8	566.3	595.0	24.8	20.8	22.8	38.8	36.0	37.4
Olgun	623.8	592.5	608.1	26.0	21.0	23.5	38.3	35.7	37.0
Oliver	660.0	578.8	619.4	22.0	18.5	20.3	38.4	36.6	37.5
Premium	543.8	528.8	536.3	22.5	18.3	20.4	43.7	38.7	41.2
Ramata	702.5	638.8	670.6	20.3	17.5	18.9	38.0	36.1	37.1
Scarpia	677.5	591.3	634.4	22.5	19.0	20.8	38.6	37.2	37.8
Seymen	555.0	493.8	524.4	23.8	20.5	22.1	42.9	39.6	41.3
Sladoran	595.0	555.0	575.0	22.5	19.0	20.8	42.2	38.4	40.3
Sultan	655.0	553.8	604.4	23.3	18.3	20.8	38.0	37.3	37.7
Tokak 157/37	516.3	492.5	504.4	18.8	16.8	17.8	43.2	40.6	41.9
Yıldız	595.0	498.8	546.9	22.5	19.3	20.9	42.3	40.5	41.4
Zeus	382.5	368.8	375.6	19.8	17.5	18.6	39.8	37.2	38.5
Akar	690.0	610.0	650.0	22.3	19.8	21.0	39.7	37.1	38.4
Akdane	537.5	510.0	523.8	23.8	20.5	22.1	39.9	36.0	38.0
Arcanda	618.8	601.3	610.0	22.0	20.3	21.1	36.2	32.8	34.5
Atılır	742.5	687.5	715.0	24.8	21.0	22.9	34.9	34.1	34.5
Başgül	621.3	566.3	593.8	23.5	20.0	21.8	39.8	36.4	38.1
Beyşehir	633.8	562.5	598.1	20.5	17.8	19.1	41.8	37.4	39.6
Burakbey	652.5	546.3	599.4	22.3	19.5	20.9	38.7	35.4	37.1
Bülbül 89	631.3	565.0	598.1	22.8	19.0	20.9	41.5	37.9	39.7
Cervoise	483.8	457.5	470.6	22.0	19.5	20.8	41.3	37.5	39.4
Cumhuriyet 50	648.8	558.8	603.8	24.3	21.0	22.6	40.6	37.2	38.9
Çıldır 02	535.0	495.0	515.0	24.8	20.0	22.4	41.7	38.7	40.2
Çumra 2001	487.5	505.0	496.3	23.8	19.5	21.6	41.1	37.7	39.4
Efes 98	645.0	580.0	612.5	22.8	19.0	20.9	42.3	38.2	40.2
Erciyes	610.0	521.3	565.6	22.0	18.3	20.1	41.9	37.9	39.9
Erginel 90	607.5	585.0	596.3	21.0	18.8	19.9	38.3	36.6	37.4
İnce-04	657.5	582.5	620.0	23.0	18.8	20.9	42.8	39.7	41.2
Kalaycı-97	640.0	572.5	606.3	23.5	19.3	21.4	41.7	38.9	40.3
Karatay 94	590.0	538.8	564.4	24.8	21.0	22.9	41.6	37.9	39.8
Keser	583.8	481.3	532.5	24.5	20.0	22.3	39.8	36.0	37.9
Kıral-97	501.3	478.8	490.0	22.0	19.3	20.6	38.6	36.7	37.8
Konevi	615.0	550.0	582.5	23.5	19.8	21.6	41.8	38.8	40.3
Larende	532.5	495.0	513.8	25.8	20.8	23.3	41.1	37.8	39.5
Martı	587.5	532.5	560.0	22.5	19.0	20.8	37.8	35.5	36.7
Orza 96	562.5	503.8	533.1	19.8	17.3	18.5	39.8	37.4	38.6
Özdemir-05	627.5	583.8	605.6	20.3	17.8	19.0	45.0	41.9	43.4
Sur-93	623.8	571.3	597.5	20.3	16.5	18.4	41.4	38.6	40.0
Şahin-91	558.8	505.0	531.9	20.3	17.3	18.8	41.4	39.0	40.2
Tarm-92	652.5	601.3	626.9	19.5	16.3	17.9	42.5	40.0	41.2
Toprak	482.5	477.5	480.0	19.8	17.5	18.6	42.7	40.1	41.4
Ünver	406.3	361.3	383.8	21.5	17.8	19.6	43.6	41.5	42.6
Yalın	611.3	557.5	584.4	21.5	18.8	20.1	38.6	36.8	37.7
Yerçil-147	641.3	590.0	615.6	19.8	16.8	18.3	38.9	37.2	38.1
Yesevi 93	640.0	592.5	616.3	20.8	17.8	19.3	40.0	37.9	39.0
Zeynel Ağa	470.0	415.0	442.5	22.5	18.5	20.5	37.0	35.2	36.1
Average	593.8	541.7	567.7	22.5	19.1	20.8	40.5	37.6	39.0

F value (Year)	-	-	142.9**	-	-	1319.9**	-	-	748.6**
F value (Variety)	8.7**	6.5**	14.8**	11.1**	6.3**	16.3**	22.2**	6.8**	21.8**
F value (Block)	2.9*	3.2*	6.1**	4.2**	1.6	5.3**	0.9	0.2	0.5
F value (YxV)	-	-	0.5	-	-	1.1	-	-	1.1
CV (%)	8.1	8.8	8.4	4.6	5.6	5.1	2.2	3.6	3.0
LSD (0.05) (Y)	-	-	8.6	-	-	0.2	-	-	0.2
LSD (0.05) (V)	67.3	66.5	47.0	1.4	1.5	1.0	1.3	1.9	1.1
LSD (0.05) (YxV)	-	-	66.4	-	-	1.5	-	-	1.6

F values with * are 0.05, F values with ** are 0.01 degrees of significance.

When the years are evaluated separately, the harvest indexes of the varieties vary between 26.3-38.3% in the 2017-2018 crop year; While the Meriç variety had the highest harvest index, this variety was followed by Olgun (38.2%), Oliver (38.0%) and Efes 98 (37.9%). Zeus variety had the lowest harvest index, followed by Toprak (28.5%), Ünver (28.5%), and Zeynel Ağa (29.8%), and the differences between the following varieties were insignificant. In the 2018-2019 crop year, the harvest indexes of the varieties varied between 25.1-36.6%; the Özdemir-05 variety had the highest harvest index, this variety was followed by Olgun (36.1%), Meriç (35.2%) and Yalın (35.2%) varieties and Özdemir-05 variety with the highest harvest index had 34.6% harvest index. The difference with the Scarpia cultivar was insignificant. While the Zeus variety had the lowest harvest index, this variety was followed by Escadre (28.3%), Beyşehir (28.4%), and Ünver (28.9%). The difference was insignificant. Kaydan and Yağmur (2007), in their study of Van conditions, reported that the harvest index of barley varieties varied between 21.11-36.43%. Akdeniz et al. (2004) reported harvest index of barley varieties was between was between 38.0-48.6%, and 15.5%-30.1% by Çöken and Akman (2016). Kırtok (1984) reported that the harvest index was affected by environmental conditions, while Singh and Stoscopef (1971) reported that the year x variety interaction was important in terms of the harvest index.

4. Conclusions

Our barley production should be increased regularly to meet the basic food needs of our growing population, concentrate feed of our animals and raw material needs of the industry, and be able to export. For this, it is important to determine the superior barley varieties in terms of adaptability and grain yield according to the regions. In this study, the winter adaptation of 60 barley cultivars to Erzurum dry farming conditions was investigated, and the highest grain yield was obtained from the Olgun cultivar. Kalaycı-97, İnce-04, and Çetin 2000 varieties also took the first place with their high grain yields. These cultivars can be suggested more confidently as alternative promising cultivars for the region by being tested in large areas and different locations.

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