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Investigation of some blackberry cultivars in terms of phenological, yield and fruit characteristics

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Abstract

This study was conducted to determine the phenological, yield and fruit quality characteristics of 4 different blackberry cultivars (Jumbo, Chester, Bursa 1 and Bursa 2) grown under the ecological conditions of Isparta, Turkey. The Jumbo and Bursa 1 cultivars stood out due to their earliness. The highest yield per plant was obtained from Bursa 1 with 5135.2 g, while Bursa 2 cultivar had the lowest yield with 1137.4 g among cultivars. Fruit width, fruit length, berry weight and shape index varied between 16.30-17.23 mm, 17.20-23.26 mm, 3.25-4.75 g and 1.06-1.35, respectively. The highest values of these properties were observed in the Jumbo cultivar, while the lowest values were measured in Chester. The pH, soluble solid content (SSC), titratable acidity (TA) and ripening index values ranged from 3.04 (Chester) to 3.16 (Bursa 1), 7.10 (Jumbo) to 9.52 (Chester), 0.98 (Chester) to 1.07 (Bursa 1) and 7.17 (Jumbo) to 9.71 (Chester), respectively. The results revealed that the Bursa 1 is the most suitable cultivar for the ecological conditions of Isparta.

Key words: Adaptation, physicochemical characterization, quality, *Rubus fruticosus* L.

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INTRODUCTION

The consumption of the species that are defined as functional foods in the medical terminology due to their outstanding phytochemical properties is growing because of the increasing public awareness of the issue (Demir and Aktas, 2018). The importance of berry fruits in a healthy and balanced diet is increasingly emphasized by dieticians and health care professionals because of their various, rich and effective phytochemical content (Şar, 2011; Sarkar et al., 2016; de Gomes et al., 2019). Blackberry is a species from the berry fruit group belonging to the *Rosales* order, *Rosaceae* family and *Rubus* genus (Agaoglu, 1986). Its wild form can be found across Turkey, but its culture is relatively new compared to other species (Onur, 1999). The insufficiency in its agricultural extension, the lack of adaptation studies and the traditionalism of farmers hinder its cultivation in Turkey. In fact, with a production of 2,504 tons, Turkey is considerably behind its potential for blackberry production (TÜİK, 2018).

The demand and price for blackberry are considerably high due to its use in various industrial forms in addition to its fresh consumption (Di Palma, 2011). Blackberry has a low ecological selectivity, regularly yields products and is important in the utilization of woman and child labor, since it requires heavy hand labor. Thus, it has a potential for use as a complementary product in agribusinesses. Recently, with the participation of the universities and leading farmers in the promotional activities of the ministry, the production, quality, yield, adaptation and breeding studies for blackberry have gained momentum across the country (Cangi and İslam, 2003; Demirsoy et al., 2006; Kafkas et al., 2006; Gundoğdu et al., 2016; Akin et al., 2016; Gündeşli et al., 2019). Its production should be increased to higher levels and spread across the country by remedying the lack of knowledge of blackberry, determining the cultivars that are suitable for different regions with adaptation studies, overcoming the difficulties in material supply, increasing yield and quality and breeding superior genotypes with modern cultivation techniques and promoting the inclusion of new producers.

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The essential goal of this study was to investigate the phenological, pomological, phytochemical and yield characteristics of the Jumbo, Chester, Bursa 1 and Bursa 2 cultivars grown under the ecological conditions of Isparta, Turkey. Thus, obtained results may increase our knowledge on investigated parameters how they effect from different growing conditions. It is thought that this study will constitute an infrastructure for the future investigations and breeding purposes.

MATERIALS AND METHODS

Material

The study was carried out using four different blackberry cultivars (Jumbo, Chester, Bursa 1 and Bursa 2) which are located in the experimental fields of Isparta University of Applied Sciences University, Faculty of Agriculture in 2018. The planting was carried out in 2015 by transferring the plants to the field using tubes of sizes of 20 x 30 and with a row and intra-row spacing of 3.5 x 1.2 m. The altitude of the study area was 1009 m and the area was located at the coordinates 37° 50′ 13.6464" and 30° 32′ 17.6316". The soil structure of the experiment site is clayey-loam with moderate alkaline and the lime content is very high. In addition to organic matter, the amount of extractable P and Zn content were found to be low. K content was medium, Mn, Fe and Cu content were found to be sufficient (Table 1) (Jackson, 1962).

Table 1. Some physical and chemical characteristics of the experimental soil

pH (1/2.5 water)	Structure	Lime (%)	Organic material	Nutrients that can be extracted (mg/kg)					
				P	K	Fe	Cu	Zn	Mn
8.1	Clayey-loam	26.0	1.9	12.6	124	3.1	0.9	0.38	2.9

The experimental area has a typical continental climate with cold-moist winter and hot-dry summer.The weather was warmer than long-term average during the experimental period. Although, June received more precipitation than the long-term average, there was lower in the remaining months and it was insufficient to meet plant water needs. Humidity was higher than long-term average except September (Table 2).

Table 2. Average weather data of Eskisehir in related months

	Precipitation (mm)		Humidity (%)		Temperature (º C)	
Months	2018	1929-2017	2018	1929-2017	2018	1929-2017
June	69.4	33.6	62.4	52.5	20.0	19.8
July	4.1	16.3	46.9	45.7	24.3	23.4
August	14.2	14.3	47.6	46.4	24.3	23.2
September	1.6	18.8	47.6	52.3	20.7	18.8

Method

Phenological observations

Coloring, formation of the abscission layer between the fruit and receptacle and taste were taken into consideration for the determination of harvest time. The period during which 5-10 fruits completed their ripening was determined as the first harvest time for the cultivars. The date at which the last ripened fruit was harvested was recorded as the final harvest (Avcı, 2013). The harvest period was found by calculating the time between the first and final harvests (Ozdemir et al., 2005).

Pomological observations

The fruits harvested from the cultivars were immediately transferred to the laboratory. The data on the parameters were obtained by using 30 fruits from each harvest from each repetition. Fruit weight was measured using an electronic scale with 0.001 g-accuracy (Sartorius - CPA 16001S) and fruit width and length were measured with a digital caliper with 0.01 mm-accuracy. Fruit shape index was obtained by proportioning the fruit length to the fruit width (Karacalı, 2012). Yield per plant was determined by taking the arithmetic mean of yields that were obtained from each repetition during the harvest period (Gunduz et al., 2013).

Phytochemical properties

In the repetitions for the cultivars, the remaining fruits from the measurements were squeezed with a juice extractor and filtered with coarse filter paper in each harvest during the harvest period. The previously collected juices were kept at -20^{o}C until the analysis that was carried out after juice was obtained from the final harvest. Soluble solid content (SSC) was measured using a digital refractometer (Atago PR-32, Japan) and the results were given in percentages (%) (Karacalı, 2012). In the determination of titratable acidity (TA), the juices were titrated with 0.1 N sodium hydroxyl using phenolphthalein as the indicator and the results were calculated using the formulation proposed by Mertoglu and Evrenosoglu (2017) and given in citric acid %. The SSC value was proportioned to total acidity to calculate the ripening index (Milosevic et al., 2012).

Statistical method

The study was designed in accordance with the completely randomized experimental design with

three replicates. The results were given in mean ± standard deviation. The presence of statistical differences in the investigated properties of the cultivars was investigated using the one-way ANOVA procedure in the Minitab-17 package program. Tukey multiple comparison test was used to find the differences among the cultivars (Zar, 2013).

RESULTS AND DISCUSSION

Jumbo and Bursa 1 cultivars were the first cultivars to reach harvest maturity (29 July). The Chester cultivar reached harvest maturity after 2 days and the Bursa 2 cultivar was the last cultivar to reach harvest maturity with a 4-day delay (Table 3). It was reported that the Bursa 1 and Jumbo cultivars reached harvest maturity on the same day during two consecutive production seasons under the ecological conditions of Hatay (Ozdemir et al., 2005) and Trabzon (Yıldız, 2011). On the other hand, studies that were carried out in different locations revealed that the Chester and Bursa 2 cultivars reached harvest maturity later than these cultivars (Ersoy, 2011; Avcı, 2013; Ilgın, 2015). The results obtained in this study showed that the number of harvests increased with prolonged harvest period. The Jumbo cultivar had the shortest harvest period of 30 days and a harvest number of 6, while the Bursa 1 cultivar reached a harvest number of 8 with the longest harvest period of 40 days. The total harvest number for the Chester and Bursa 2 cultivars was 7 and their harvest periods were 32 and 36 days, respectively (Table 3). In Kahramanmaraş, the harvest periods of the Bursa 1 and Chester cultivars decreased to 28 and 29 days, respectively (Ilgın, 2015), while their harvest periods reached 35 and 33 days in Malatya. Mertoglu et al (2018) reported that the phenological progress was shorter when temperature was higher and longer when the temperature decreased. In the study, the longer harvest period compared with the results found in the literature is attributable to the low summer temperatures in Isparta.

The differences between the cultivars in terms of yield per plant were statistically significant (Table 3). The highest yield was obtained from Bursa 1 with 5135.2 g, while the lowest yield was obtained from Bursa 2 with 1137.4 g among the cultivars. In a study carried in the Eğirdir region of the same city, the most productive cultivar in terms of yield per plant was determined to be the Bursa-1 (4660.77 g) cultivar, while the Bursa 2 cultivar had the lowest yield value (1785.70 g) (Göktas et al., 2006). The yield values of the Chester and Jumbo cultivars were 2545.5 g and 2013.1 g, respectively. The yield values found in the study agree with the results found in the literature (Avcı, 2013; Ilgın, 2015).

Table 3. Evaluation of the cultivars in terms of their phenological, pomological, phytochemical and yield characteristics

Phenological Characteristics					
	First harvest	Final harvest	Harvest period (days)	Harvest number	Yield (g/plant)
Jumbo	**29.07**	**27.8**	**30**	**6**	2013.1±369.7^{c}
Chester	**31.07**	31.8	32	7	2545.5±428.7^{b}
Bursa 1	**29.07**	**6.9**	**40**	**8**	**5135.2±468.1^{a}**
Bursa 2	02.08	**6.9**	36	7	**1137.4±160.9^{d}**
Pomological Characteristics					
	Width (mm)		Length (mm)	Berry weight (g)	Shape index
Jumbo	**17.23±1.08^{a*}**		**23.26±2.38^{a}**	**4.75±0.90^{a}**	**1.35±0.11^{a}**
Chester	**16.30±0.86^{b}**		**17.20±1.76^{c}**	**3.25±0.55^{c}**	**1.06±0.10^{d}**
Bursa 1	16.64±1.41^{ab}		21.02±2.20^{b}	4.19±0.99^{b}	1.27±0.09^{b}
Bursa 2	16.31±1.32^{b}		17.92±1.99^{c}	3.39±0.68^{c}	1.10±0.09^{c}
Phytochemical Characteristics					
	pH		SSC (%)	TA (%)	Ripening index
Jumbo	3.15±0.12^{a}		**7.10±1.31^{c}**	0.99±0.21^{ns**}	**7.17±1.10^{b}**
Chester	**3.04±0.06^{b}**		**9.52±0.90^{a}**	**0.98±0.07^{ns}**	**9.71±0.69^{a}**
Bursa 1	**3.16±0.07^{a}**		8.04±1.85^{bc}	**1.07±0.25^{ns}**	7.51±1.00^{b}
Bursa 2	3.15±0.06^{a}		9.08±1.46^{ab}	1.03±0.14^{ns}	8.82±0.86^{a}

*: There is no statistically significant difference between the averages indicated by the same letter in the same column ($p<0.01$)

**: non-significant

The differences between all pomological characteristics of the cultivars were statistically significant. The fruit width, fruit length, berry weight and shape index values ranged from 16.30 to 17.23 mm, 17.20 to 23.26 mm, 3.25 to 4.75 g and 1.06 to 1.35, respectively. In terms of these properties, Jumbo showed the highest values, while the lowest values were measured in Chester cultivar (Table 3). Although the results found for these parameters agree with those found by Turemis et al. (2003) and Ozdemir et al. (2005), they were lower than those found by Gercekcioglu and Esmek (2005) and Milosevic et al. (2012) and higher than those found by Gunduz et al. (2013). During the flowering and fruit set stages, cool weather allows increased gibberellic acid and cytokinin production in growth cones (Shaw. 1914).

The cellular increase in the calyx and pedicel lobes leads to longer fruit axis and peduncle. In regions with higher temperatures, fruits are pudgier due to increased auxin production (Sherman and Beckman 2002). Eccher and Noe (1992), Wert et al. (2007) and Guler and Yıldırım (2016) reported that the fruit length/fruit width values increased due to decreased temperature in apple, peach and pomegranate, respectively. The fruit diameter of lemon and orange increased with increasing temperature (Nauer et al 1974; Nauer et al 1975). Fruit width and length have a high correlation with fruit weight (Sarıdas et al., 2017). Thus, the changes in pomological characteristics under different ecological conditions are common. Moreover, factors such as the cultivation system, cultural practices and crop load affect the final shape of the product (Di Vittori et al., 2018).

Except for titratable acidity, the differences between the phytochemical properties of the cultivars were statistically significant. The pH, SSC, TA and ripening index values ranged from 3.04 (Chester) to 3.16 (Bursa 1), 7.10 (Jumbo) to 9.52 (Chester), 0.98 (Chester) to 1.07 (Bursa 1) and 7.17 (Jumbo) to 9.71 (Chester), respectively (Table 3). Although the results varied within the limits obtained in previous studies, the SSC and TA values were generally lower and ripening index values were higher than those obtained in previous studies (Turemis et al., 2003; Gercekcioglu and Esmek. 2005; Agaoglu et al., 2007; Milosevic et al., 2012; Gunduz et al., 2013; Ilgın. 2015; Colak. 2018; Balcı and Keles. 2019). Plant biochemistry is directly affected by climatic events especially during the period close to harvest and change in parallel with changing ecological conditions (Palmieri et al., 2017). Furthermore, factors such as the geography of the production area, harvest type and time, storage and processing of the product and methodological or seasonal differences of cultural practices significantly change the final phytochemical composition (Li et al., 2012; Tiwari and Cummins. 2013; Gunduz and Ozbay. 2018; Molmann et al., 2018; Usanmaz et al., 2018; Colak et al., 2019).

CONCLUSIONS AND RECOMMENDATIONS

In the study, the yield and fruit characteristics of four blackberry cultivars, which can be sold at high prices and is important for agribusinesses especially in the utilization of woman and child labor, were examined under the ecological conditions of Isparta, Turkey.

The Bursa 1 cultivar was superior to other cultivars in terms of its yield, while the Jumbo cultivar stood out with its pomological properties. These two cultivars were harvested on the same day and showed earliness when compared with the other cultivars. However, the shortness of the harvest period in the Jumbo cultivar led to a shorter period for product supply and low yield. The Bursa 1 cultivar showed a good performance with its contrasting properties.

In terms of phytochemical characteristics, with its low pH, the use of the Chester cultivar in the processing of industrial products has a potential for higher product stability and lower bacterial activity. Moreover, due to its high SSC and ripening index, it will probably have a good productivity and taste in these products.

The results will help breeders and researchers by serving as a foundation for yield, industrial and breeding purposes.

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