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Comparison of Different Blackberry (*Rubus fructicosus* L.) Cultivars in Tokat, Turkey

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Abstract: The study evaluates different red raspberry cultivars for their adaptation capabilities to recommend to growers in Central Anatolia. The experimental plots were planted with 7 cultivars in 1999. The observations made over 2 years, on the fallowing traits; berry weight, berry shape, pH, total soluble solid, acidity, sensory analysis, shoot length and diameter and yield (kg ha^{-1}). The flowering period lasted 7-23 days and the harvest generally started in the second week of July. Mean average berry weights were ranged from 2.83 to 7.88 g. Mean yields ranged from 3.73 kg $plot^{-1}$ (for Arapaho) to 41.27 kg $plot^{-1}$ (for Bursa I)

Key words : Blackberry, cultivars, evaluation, Tokat province

INTRODUCTION

Soft fruit such as raspberry, blackberry, currant, rose hip etc. are grown and consumed in various appealing ways in the world. Therefore, soft fruits are grown in many areas from arctic to tropic zone in world. Turkey places in this zone and several forms of different species of berries are grown in every region of Turkey[1].

Many blackberry species are native to Turkey as well and berries can be grown in the all part of the country in the presence of irrigation[2]. Although the plenty of forms of species, there are a few commercial cultivation of blackberry. There is partly blackberry cultivation in the Marmara region. This is due to absence of standard or improved cultivars of berries. Although the improvement and cultivation of berries have been done for along time, over 100 years, in the world, the interest to blackberry cultivation has been increased in recent two decades in our country. Also in recent years some selection and improvement studies have been carried out on soft fruits[1,3]. In addition to these works, some standard cultivars have been introduced from USA and European countries and already adaptation performance of these cultivars are being tested in various regions of Turkey.

The berries are used in industry for ice cream, juice, jam, marmalade, cake pastry etc.[4,5]. In addition, flavanoids and phenolic compounds in the berries are anti-carcinogens; therefore, blackberry berries are used in medicine as well[6,7].

There are many studies[1-3], that characterize fruit and plant of several blackberry cultivars but none has been examined for production in Turkey or Middle Eastern countries. In many regions such as Tokat/Turkey, most of growing areas are suitable for blackberry[3]. The aim of this study was to compare different cultivars to recommend adapted cultivars to farmers of Tokat, Turkey.

MATERIALS AND METHODS

The seven blackberry genotypes used in this study were: Arapaho, Cherokee (Thorny), Jumbo, Nessy, Bursa I, Bursa II and Bursa III. The last three cultivars are selections from the Marmara and Black Sea Regions in Turkey.

The trial was established in 1999, in a randomized complete block design with three replicates, 30 berry per replicate. Plants were spaced at 2 m within rows spaced 2 m apart. Trickle irrigation was installed shortly after planting and water was applied as needed. Fruiting of all cultivars started in 2000 with a small harvest; However, in this paper the results of 2001 to 2002 are presented (2 years results).

The study was conducted at the Field Horticultural Department, Gaziosmanpasa University, Faculty of Agriculture, Tokat, Turkey (40°13'-40°22'N, 36°1'-36°40'E, altitude 525 m). Some climatic data for the research area are given Table 1. The experimental soil is slightly alkaline in reaction (pH 8.08), medium in calcium carbonate content (13.8%), poor in P content (0.5 mg P_2O_5 100 g^{-1} soil), medium K content (12.7 mg K_2O 100 g^{-1} soil) and medium in organic matter (2.15%).

The fruits were harvested two or three times a week. Otherwise, plant characteristics were examined during the dormant period. Yield data were also obtained as kg ha^{-1}[8-11]. The cane diameter was measured 5 and 50 cm above soil level. Mean primocane length and diameter were measured, as recommended by Davidson[12].

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Table 1: Ecological characteristics for the experimental area

	Max. temp.		Min. temp.		Mean temp.		Monthly rainfall		Relative humidity	
Months	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
Jan.	11.5	17.4	-20.3	-7.3	-4.5	5.5	45.1	27.8	90.6	82.2
Feb.	18.2	15.0	-7.9	-9.0	4.1	2.2	20.4	21.8	76.7	73.7
March	24.7	15.6	-6.6	-9.8	9.3	3.0	29.2	16.4	63.8	75.0
April	24.0	27.2	-3.2	-3.8	11.1	11.0	68.4	75.6	76.6	70.2
May	33.3	33.5	0.0	-0.2	15.6	17.0	16.8	11.8	65.1	64.6
June	35.9	33.6	7.0	3.3	18.8	18.2	57.6	11.4	76.4	66.8
July	39.4	39.0	9.3	5.6	23.2	21.7	37.6	1.4	70.4	64.6
Aug.	37.4	35.9	7.9	7.4	21.4	21.2	11.2	0.2	72.1	66.5
Sept.	32.3	36.9	3.6	4.7	18.8	16.9	11.4	37.8	75.0	77.6
Oct.	29.4	34.1	-4.4	-4.8	13.4	12.5	35.8	35.9	79.6	65.5
Nov.	23.6	28.0	-3.2	-12.8	6.9	7.0	33.8	46.7	86.5	69.6
Dec.	18.6	25.0	-28.0	-28.0	-2.0	3.2	25.0	45.9	86.1	71.4

*: The meteorological station of general directorate of rural services (the altitude is 525 m)

Mean fruit weight (g) and fruit dimensions (length and width as mm) of 90 berries were determined. Total Soluble Solid (TSS) was determined at 20°C with a hand-held refractometer (Hand Sugar Refractometer, model WYT-1). Results were expressed in terms of berry weight (%). The pH was measured in the non-diluted of juice, using a pH meter. Total acidity was expressed as percentage of citric acid; aliquots of 5-10 mL berry juices were diluted with 40-50 mL of pure water. Prepared juice was titrated with 0.1 N NaOH, up to pH 8.1. This potentiometer titration was performed with a pH combined electrode HI 2031 B/HI 2020 S[8].

A jury is made the sensory analysis as recommended by Stevens and Albright[11]. A 5 -point hedonic scale was used: 1: dislike extremely; 3: either like or dislike and 5: like extremely. Each panelist was asked to note three main components of berry quality; color, firmness and flavor together with overall berry quality.

All the statistical analysis were conducted according to Gomez and Gomez[13]. LSD' s procedure was used to test for significant differences among the blackberry cultivars.

RESULTS AND DISCUSSION

Flowering started in all cultivars between the May 14 and June 7. Flowering periods were longer in 2000 compared to other years. The cultivars Arapaho (25th March in 2002)' and Cherokee (27th March in two years) flowered earlier than the others; the blooming of other cultivars differed from year to year. Phenological characteristics, especially flowering periods, varied due to cultivars and ecological conditions[9,10,14].

Starting date of harvest and harvesting periods varied among years and the cultivars. In general, harvest started in 25th June (for Arapaho in 2001) lasted to 26th August (for Nessy in 2002). Arapaho and Cherokee cultivars were harvested earlier than the others. Number of harvest was between (except 2000 year) 6 (Cherokee) and 14 (Bursa I) and harvest periods varied from 19 days (for Cherokee in 2002) to 40 days (for Nessy in 2002). Phenological characteristics, including harvest periods, vary because of cultivars and ecological conditions[4,15].

Cane characteristics were observed in 2001 and 2002 (Table 2). The largest diameter was found in Bursa I as 23.60 cm and in Jumbo as 23.53 cm in from 5 cm ground level in 2002. Cane height ranged from 187 cm (for Nessy) to 638 cm (for Bursa III).

Berry mean weight ranged 2.83-7.88 g (Table 3). Jumbo had the largest berry weight for two years. Otherwise, Bursa, Arapaho and Cherokee had the largest berry. Present results were lower with the findings of Turemis *et al.*[2] for Bursa II and Bursa III and in agreement with the findings of Turemis *et al.*[2] and of Moore and Clark[16] for Bursa I and Arapaho.

Yield which varies by years, is also an important quality indicator. Bursa I and Jumbo had the highest average yield and Arapaho had fallowing the lowest (Table 4). Mean yields of Bursa I and Jumbo were higher compared to these observations done by Turemis *et al.*[2] present results were in agreement with the findings of Moore and Clark[16] for Arapaho.

The highest percentage of TSS was in Arapaho and Cherokee in two years, whereas Bursa I and Jumbo had lowest TSS mean percentage among seven cultivars (Table 5). Values for TSS concentration cited[16,17] as 9.20% for Arapaho. These cited values are no similar to our findings. Our study were higher than in studies of Alleyne and Clark[17] and Moore and Clark[16]. Others reported TSS concentration and total acidity were 9.4 and 1.1% for Bursa II; 9.3 and 1.0% for Bursa III; 9.0 and 0.9% for Jumbo, respectively in 2002[2]. Mean TSS and total acidity (Table 6) of Bursa II, Bursa III and Jumbo in study were higher than in studies of Turemis *et al.*[2]. Present values for pH were higher than values reported for all vanities by Turemis *et al.*[2]. pH ranged 3.17 (Bursa I in 2001) to 3.54 (Bursa III in 2002).

Table 2: Some cane characteristics of seven blackberry cultivars

Cultivars	2001 Cane height (cm)	Cane diameter (mm)* 5 (cm)	50 (cm)	2002 Cane height (cm)	Cane diameter (mm)* 5 (cm)	50 (cm)
Arapaho	230.58	14.51	12.13	222.07	16.70	13.48
Bursa I	239.50	9.72	6.57	283.33	23.60	19.15
Bursa II	624.50	18.11	11.68	378.67	16.75	8.15
Bursa III	638.50	18.54	12.08	588.67	10.63	6.83
Cherokee	225.00	17.48	19.04	246.97	16.13	11.65
Jumbo	438.13	19.22	13.41	602.03	23.53	16.93
Nessy	187.78	19.58	11.34	382.47	23.47	18.12

*: Cane diameter was measured over soil surface level

Table 3: Fruit weights (g) of seven blackberry cultivars

Cultivars	2001	2002	Mean
Arapaho	3.64	4.73	4.18c
Bursa I	4.84	6.43	5.64b
Bursa II	2.63	3.04	2.83d
Bursa III	3.06	3.33	3.20d
Cherokee	3.64	4.74	4.19c
Jumbo	6.82	8.93	7.88a
Nessy	3.04	5.27	4.16c
Average	3.95b	5.21a	

LSD (Year): 0.475**, LSD (Cultivar): 0.899**, LSD (Year x Cultivar): 0.929*, *:Means with same letter are not different at the p=0.05(*) and p=0.01(**)

Table 4: Yield (kg plot^{-1}) of seven blackberry cultivars

Cultivars	2001	2002	Mean
Arapaho	3.82	3.65	3.73d
Bursa I	32.10	50.45	41.27a
Bursa II	12.80	7.79	10.29cd
Bursa III	25.23	9.81	17.52c
Cherokee	9.10	5.23	7.17d
Jumbo	51.27	20.45	35.86ab
Nessy	21.98	35.43	28.71b
Average	22.33	18.98	

LSD (Year): ns LSD (Cultivar): 8.083**, LSD (Year x Cultivar): 11.431**, *: Means with same letter(s) are not different at the p=0.05(*) and p=0.01(**)

Table 5: Total soluble solid (%) of seven blackberry cultivars

Cultivars	2001	2002	Mean
Arapaho	11.89	11.87	11.88a
Bursa I	8.72	9.23	8.98c
Bursa II	11.17	11.08	11.13ab
Bursa III	9.61	10.42	10.02bc
Cherokee	11.45	11.77	11.61a
Jumbo	8.94	9.77	9.35c
Nessy	11.50	9.42	10.46a-c
Mean	10.47	10.51	

LSD (Year): ns, LSD (Cultivar): 1.524, LSD (Year x Cultivar). *: Means with same letter (s) are not different at the p=0.05(*) and p=0.01(**)

Table 6: Total acidity (%) of seven blackberry cultivars

Cultivars	2001	2002	Mean
Arapaho	1.71	1.70	1.71cd
Bursa I	2.22	2.23	2.23a-d
Bursa II	1.97	3.46	2.72a
Bursa III	2.11	2.75	2.43ab
Cherokee	1.61	1.65	1.63d
Jumbo	2.16	1.67	1.92b-d
Nessy	1.90	2.61	2.26a-c
Mean	1.95b	2.29a	

LSD (Year): 0.331**, LSD (Cultivar): 0.619**, LSD (Year x Cultivar): 0.875**, *: Means with same letter(s) are not different at the p=0.05(*) and p=0.01(**)

The fruit shape index (length/width) of cultivars was beyond 1.0 except of Bursa I, Buras II and Bursa III. The fruit firmness of all cultivars were as very firm and hard. Based on the texture and flavour, the cultivars can be categorized (except for Jumbo, 5: like extremely) as good and can be categorized as medium quality (3: either like or dislike).

CONCLUSIONS

This study was conducted to recommend adapted cultivars of blackberry to the farmers in Tokat region of Turkey. For this purpose 7 cultivars were studied during 2001-2002 years. It is concluded that among the tested cultivars, Bursa I and Jumbo seems to have better yield and fruit characteristics than the others. Nessy and Bursa III with good adaptation capability also had acceptable results and can be recommended to growers. In conclusion, blackberry has good potential as a commercial crop in the Central Anatolia region of Turkey for fresh and processing markets.

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