

Fruit Characteristics of Nine Thornless Blackberry Genotypes

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Abstract

Fruit characteristics of nine semierect and trailing thornless blackberry genotypes were evaluated in Adana province, in the Mediterranean region of Turkey. Five cultivars ('Chester Thornless', 'Jumbo', 'Loch Ness' ('Nessy'), 'Navaho' and 'Dirksen Thornless') and four selections (Bursa-1, Bursa-2, Bursa-3 and Bartin) were characterized in 2001 and 2002. The genotypes were compared for yield, fruit weight, concentration of total soluble solid (TSS), fruit acidity, TSS / acidity ratio, pH, color and harvest periods. The highest TSS content was in 'Navaho'; the heaviest berries were in 'Jumbo'; the highest yield was in 'Chester Thornless'; and the longest harvesting period was in 'Jumbo' and 'Navaho' in both years.

Introduction

Commercial blackberry (*Rubus sp.* L.) cultivars have primarily been developed from *Rubus* species native to North America. There are many blackberry cultivars with different characteristics such as thorny or thornless, trailing, erect or semi-erect growth habit (5). Thornless cultivars are mostly trailing or semi-erect types. Turkish growers prefer thornless and erect type cultivars, since they are easier to manage.

The fruits are used in industry for ice cream, juice, jam, marmalade, cake etc. (2). In addition, flavonoids and phenolic compounds in the fruit are anti-carcinogens; therefore, blackberry fruits are used in medicine as well (6).

There are many studies (1, 3, 4, 7, 8, 9, 10, 11, 12), that characterize fruits of several blackberry cultivars but none have examined production in Turkey or Middle Eastern countries. Many blackberry species are native to Turkey and blackberries can be grown in the all parts of the country in the presence of irrigation. In Turkey, blackberry cultivation started in the Mar-

mara region several decades ago; now blackberry is a new crop in the Mediterranean region.

In the Mediterranean region of Turkey, there has been no study comparing fruit quality characteristics of blackberry cultivars. In this study, nine thornless blackberry genotypes grown in Adana province, in the Mediterranean region of Turkey were characterized for their fruit characteristics and yield. Blackberry may be a good alternative crop with high market value for farmers in this region.

Materials and Methods

The nine thornless blackberry genotypes used in this study were: 'Chester Thornless', 'Navaho', 'Dirksen Thornless', 'Jumbo', 'Loch Ness' ('Nessy'), Bursa-1, Bursa-2, Bursa-3 and Bartin. The last four genotypes are selections from the Marmara and Black Sea regions of Turkey. The planting was established in February 1999 in a completely randomized design with three replicates (each replicate containing two plants). Fruiting of all cultivars

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started in 2000 with small crops; in this paper the results of 2001 and 2002 are presented. The fruits were harvested twice a week and fruit analysis was performed in one harvest weekly. The fruits were characterized for fruit weight, percentage of total soluble solids (TSS), pH, fruit color, percentage of fruit titratable acidity (TA) and TSS/TA ratio. Random samples of 100 fresh fruits were used directly for all fruit analyses. Yield data were also obtained. Full harvest periods were calculated by counting the days that had 5%-95% of total yield. In 2001, we harvested sunburned fruits in the beginning of the harvest and then the plants were shaded immediately. Sunburn was not observed in the following year, so shading was not applied in 2002.

Average fruit weight (g/fruit) was calculated as the mean weight of samples of 100 berries. TSS% were determined with a hand-held refractometer, using drops of homogenized juice from 100 fruits. Homogenized juice pH was measured using a pH meter. Acidity expressed as percentage of citric acid, was obtained from 1 ml sample of fruit juice titrated to pH 8.2 with 0.1 N NaOH. Surface color of berries was measured on two sides on each of 10 fruit using a tristimulus colorimeter (model CR300,

Minolta, Ramsey, N.J.). The fruit color measurement was done immediately after harvest only in 2002, whereas all the other analyses were performed in both years.

All the statistical analyses were done by completely randomized design with three replicates using the Costat package program. Tukey's procedure (HSD, $p=0.05$) was used to test for significant differences among the blackberry genotypes.

Results and Discussion

The yield data of the genotypes are shown in Figure 1. 'Chester Thornless' had the highest yield in both years, whereas 'Dirksen Thornless' produced the lowest. Bursa 2 and 'Loch Ness' also had good yield in both years.

In this study, the heaviest fruits were obtained from 'Jumbo' whereas 'Navaho' produced the lightest berries in the both years (Tables 1 and 2). Average fruit weights of 'Chester Thornless', 'Navaho' and 'Dirksen Thornless' in our study were lower than in studies done by Moore and Clark (7,8); Perkins-Veazie et al. (9,10) Strik et al. (13) and by Galletta et al. (4). The highest percentage of TSS was in 'Navaho' in both years, whereas Bursa-3 in 2001 and Bursa-1 in 2002 had lowest

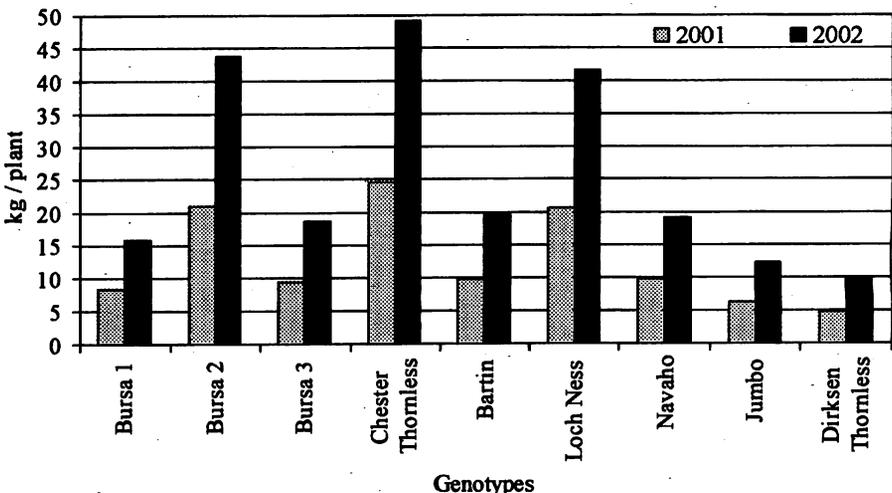


Figure 1. The yield of nine thornless blackberry genotypes in 2001 and 2002.

Table 1. Fruit characteristics of nine thornless blackberry genotypes in 2001

| Genotype | Berry weight (g/fruit) | Total soluble solids (%) | Titrateable acidity (%) | TSS/TA | pH |
|--------------|------------------------|--------------------------|-------------------------|---------|-----|
| Bursa-1 | 4.5 ab* | 7.1 d | 1.7 ab | 4.2 de | 2.8 |
| Bursa-2 | 3.3 bc | 9.0 abc | 1.7 ab | 5.3 bcd | 2.9 |
| Bursa-3 | 3.4 bc | 6.8 d | 1.9 a | 3.5 e | 2.9 |
| C. Thornless | 4.5 ab | 8.8 bc | 1.9 a | 4.7 cde | 2.6 |
| Bartin | 3.3 bc | 8.9 abc | 1.5 bc | 6.0 bc | 2.7 |
| Loch Ness | 4.4 ab | 9.7 ab | 1.4 c | 7.0 a | 2.7 |
| Navaho | 2.3 c | 10.1 a | 1.5 bc | 6.6 ab | 2.9 |
| Jumbo | 5.5 a | 7.9 cd | 1.4 c | 5.7 bcd | 2.7 |
| D. Thornless | 3.3 bc | 7.3 d | 1.5 bc | 5.0 cde | 2.8 |
| Average | 3.8 | 8.4 | 1.6 | 5.4 | 2.8 |

*Means with same letter are not significantly different by Tukey's HSD at the $P=0.05$ level

TSS percentages. In the literature, TSS concentration was 9.5% for 'Dirksen Thornless' (11) which is slightly higher than our results and 10.8-11.1% for 'Navaho' (7,8) which is similar to the our results. The 'Chester Thornless' and Bursa 3 had the most acidic berries, whereas 'Jumbo' and 'Loch Ness' berries were the least acidic in 2001. There was no significant difference in 2002.

The ratio of TSS to acidity is generally a good indicator of fruit quality. In this study, 'Navaho' and 'Loch Ness' had the best ratios, whereas Bursa-3 had the lowest ratio in 2001. In 2002, Bursa 3, 'Navaho' and 'Jumbo' had the highest ratios but the differences among the nine genotypes were not significant. Bursa 3 seemed to be very sensitive to light, as indicated by the difference in quality between the shaded and unshaded years.

The differences in pH of the berries were not significant in either year. The data ranged between 2.6 ('Chester Thornless') and 2.9 (Bursa 2, Bursa 3 and 'Navaho') in 2001 and 1.7 (Bursa-1) and 2.2 ('Navaho') in 2002. Acidity and pH values were similar to values reported by Sapers et al. (11).

The fruit characteristics except average fruit weight were different in two years (Tables 1 and 2). In 2001, fruit acidity and pH were significantly higher than in the 2002, whereas TSS and the ratio of TSS to acidity were lower in 2001. These results were expected, because the plants were shaded during the harvest in the first year to protect berries from sunburn. In the Mediterranean countries, shading may be necessary to protect the fruits from excessive sunlight, especially during mid-summer in some years; however shading reduced the fruit quality in this study.

Table 2. Fruit characteristics of nine thornless blackberry genotypes in 2002

| Genotype | Berry weight (g/fruit) | Total soluble solids (%) | Titrateable acidity (%) | TSS/TA | pH |
|--------------|------------------------|--------------------------|-------------------------|--------|-----|
| Bursa-1 | 5.2 b* | 7.8 c | 1.1 | 7.1 | 1.7 |
| Bursa-2 | 3.3 ef | 9.4 b | 1.1 | 8.6 | 2.1 |
| Bursa-3 | 4.0 de | 9.3 b | 1.0 | 9.6 | 2.1 |
| C. Thornless | 4.3 cd | 10.0 ab | 1.2 | 8.5 | 2.0 |
| Bartin | 4.3 cd | 9.5 b | 1.3 | 7.3 | 1.8 |
| Loch Ness | 5.0 bc | 9.3 b | 1.3 | 7.1 | 2.0 |
| Navaho | 2.7 f | 11.3 a | 1.2 | 9.6 | 2.2 |
| Jumbo | 6.1 a | 9.0 bc | 0.9 | 9.6 | 2.0 |
| D. Thornless | 3.7 de | 9.0 bc | 1.1 | 7.7 | 1.8 |
| Average | 4.3 | 9.4 | 1.1 | 8.4 | 2.0 |

*Means with same letter are not significantly different by Tukey's HSD at the $P=0.05$ level

Tristimulus reflectance measurements made on the intact fruit indicated significant differences among genotypes (Table 3). 'Navaho', 'Chester Thornless' and Bursa-2 had lighter (higher 'L*' values) berries. The highest a* and b* values were detected in 'Dirksen Thornless', Bursa-1 and 'Jumbo', whereas the lowest ones were in 'Chester Thornless' and 'Navaho'. 'Dirksen Thornless' and Bursa-1 were more vivid (higher 'C' values) than the other cultivars, and 'Chester Thornless' was the least vivid. Tristimulus reflectance values in our study were similar to values reported by Sapers et al. (11) and were lower than reported by Perkins-Veazie (9).

Starting date of harvest and harvest periods varied between years and among the genotypes. Harvest started with 'Navaho' and Bursa-1 and continued with Bartin, 'Chester Thornless' and Bursa-2. The full harvest season of Bursa-1, 'Navaho' and 'Jumbo' was longer than the others. Galletta et al. (4) determined harvest period of 'Chester Thornless' as 61 days and it was 28 days for 'Dirksen Thornless' in Maryland, USA. The harvest period of 'Navaho' was 34-41 days in Arkansas (7,8).

The results from this study provide information about fruit characteristics of nine thornless blackberry genotypes grown in

the Turkish Mediterranean climate. Among the tested genotypes, 'Chester Thornless' seems, to have better yield and fruit characteristics than the others. 'Jumbo' had the heaviest fruits and a good TSS / acidity ratio. It was one of the earliest cultivars and had a long harvest period, but its yield was lower. In conclusion, blackberry has good potential as a commercial crop in the Mediterranean region of Turkey for fresh and processing markets.

Literature Cited

1. Antunes, L., N.N.J. Chalfun, M.A. Regina, and A. Hoffmann. 2000. Blossom and ripening periods of blackberry varieties in Brazil. *J. Amer. Pomol. Soc.* 54:164-169.
2. Crandall, P.C. 1994. *Bramble Production. The management and marketing of raspberries and blackberries.* Food Products Press. The Haworth Press, Inc., New York, USA.
3. Finn, C.E. and F.J. Lawrence. 1998. 'Black Butte' trailing blackberry. *HortScience*: 33:355-357.
4. Galletta, G.J., A.D. Draper, J.L. Maas, R.M. Skirvin, H.G. Otterbacher, J. Swartz, and C.K. Chandler. 1998. 'Chester Thornless' blackberry. *Fruit Var J.* 52:118-122.
5. Gough, R. E. and E.B. Poling, 1996. *Small Fruits in the Home Garden.* Food Products Press. The Haworth Press, Inc, New York, USA.
6. Hakkinen, S.H. and A.R. Torronen. 2000. Content of flavonols and selected phenolic acids in

Table 3. Tristimulus colorimetric measurements in nine thornless blackberry genotypes

| Genotype | L ^Z | a ^Y | b ^X | C ^W | Hue Angle (H°) ^V |
|--------------|----------------------|----------------|----------------|----------------|-----------------------------|
| Bursa-1 | 11.3 ef ^U | 7.3 a | 2.7 b | 7.8 a | 20.5 b-e |
| Bursa-2 | 13.7 ab | 5.2 bc | 1.6 ef | 5.4 bc | 16.7 f |
| Bursa-3 | 12.9 bc | 4.9 cd | 1.9 d | 5.3 cd | 21.8 bcd |
| C. Thornless | 14.0 ab | 3.7 e | 1.3 f | 4.0 f | 19.9 cde |
| Bartin | 12.4 cd | 4.3 de | 1.7 de | 4.6 de | 22.1 bc |
| Loch Ness | 13.0 bc | 4.3 de | 1.5 ef | 4.6 ef | 18.9 ef |
| Navaho | 14.5 a | 4.1 e | 1.4 f | 4.3 ef | 19.4 de |
| Jumbo | 11.8 de | 5.6 b | 2.3 c | 6.1 b | 22.8 ab |
| D. Thornless | 10.5 f | 7.4 a | 3.4 a | 8.1 a | 24.8 a |

^ZLightness

^Yred(+) to green(-) color(-a:0°→+a:180°)

^Xyellow(+) to blue(-) color(-b:270°→b:90°)

^WChroma:√(a*)²+ (b*)²

^VHue angle=tan[b/a]

^UMeans with same letter are not significantly different by Tukey's HSD at the P=0.05 level.

Table 4. Harvest periods of nine thornless blackberry cultivars

| Genotype | Harvest 2001 | | | | | Harvest 2002 | | | | |
|--------------|--------------|-----------|------|--------------|---------------|--------------|-----------|------|--------------|---------------|
| | Start (A) | Full | | Final (B) | A-B (days) | Start (A) | Full | | Final (B) | A-B (days) |
| | | Period | Days | | | | Period | Days | | |
| Bursa-1 | 6/22 | 6/26-8/13 | 49 | 8/20 | 60 | 6/14 | 6/17-8/02 | 47 | 8/05 | 53 |
| Bursa-2 | 7/2 | 7/05-8/18 | 44 | 8/20 | 50 | 7/1 | 7/04-8/10 | 37 | 8/12 | 43 |
| Bursa-3 | 7/5 | 7/09-8/20 | 43 | 8/27 | 54 | 6/27 | 7/01-8/15 | 46 | 8/19 | 54 |
| C. Thornless | 7/2 | 7/12-8/20 | 40 | 8/24 | 47 | 7/1 | 6/27-8/01 | 42 | 8/12 | 52 |
| Bartin | 7/5 | 7/09-8/20 | 43 | 8/23 | 50 | 7/1 | 7/04-8/15 | 43 | 8/19 | 50 |
| Loch Ness | 6/26 | 7/02-8/10 | 40 | 8/13 | 49 | 6/24 | 6/27-8/08 | 43 | 8/12 | 50 |
| Navaho | 6/22 | 6/26-8/13 | 49 | 8/20 | 60 | 6/14 | 6/22-8/08 | 48 | 8/12 | 60 |
| Jumbo | 6/22 | 6/26-8/13 | 49 | 8/20 | 60 | 6/22 | 6/27-8/15 | 50 | 8/18 | 58 |
| D. Thornless | 7/1 | 7/09-8/20 | 43 | 8/20 | 51 | 7/1 | 7/04-8/12 | 39 | 8/19 | 50 |

strawberries and *Vaccinium* species: influence of cultivar, cultivation site and technique. Food Res. Int. 33:517-524.

7. Moore, J.N. and J.R. Clark. 1989. Erect thornless blackberry. HortScience. 24:863-865.
8. Moore, J.N. and J.R. Clark. 1993. 'Arapaho' erect, thornless blackberry. HortScience. 28:861-862.
9. Perkins-Veazie, P., J.K. Collins, and J.R. Clark. 1993. Fruit characteristics of some erect blackberry cultivars. HortScience. 28:853.
10. Perkins-Veazie, P., J.K. Collins, and J.R. Clark. 1996. Post-harvest quality of fruit from erect blackberries. HortScience. 31: 258-261.
11. Sapers, G.M., A.M. Burgher and J.G. Phillips. 1985. Composition and color of fruit and juice of thornless blackberry cultivars. J. Amer. Soc. Hort. Sci. 110: 243-248.
12. Skirvin, R. M., M.C. Chu, and E. Gomes, 1991. In vitro propagation of thornless trailing blackberries. HortScience. 16: 310-312.
13. Strik, B., J. Mann, and C. Finn, 1996. Percent drupelet set varies among blackberry genotypes. J. Amer. Soc. Hort. Sci. 121: 371-373.



Flower Differentiation and Spur Leaf Area in Almond

Flowers are borne laterally and mostly on spurs in mature almond trees. The flower buds contain a single terminal flower but no leaves. The authors studied the timing of floral initiation and organogenesis among and within spurs on 'Nonpareil' almond (*Prunus dulcis* [Mill.] D.A. Webb). The progress of floral initiation and differentiation among spurs varied extensively. Spurs having large total leaf areas had more floral buds and these buds made the transition to flowering earlier than spurs with smaller leaf areas. The results indicate that spurs function independently with regard to floral development, and that even within spurs, buds may also function somewhat independently as well. From: Polito, V.S., K. Pinney, R. Heerema, and S.A. Weinbaum. 2002. J. Hort. Sci. Biotech. 77:474-478.