The effect of gibberellic acid applications on the cracking rate and fruit quality in the ‘0900 Ziraat’ sweet cherry cultivar

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This study was conducted to determine the effects of different gibberellic acid (GA3) doses (0, 5, 10, 15, 20 and 25 ppm) on the fruit quality and cracking rate in the ‘0900 Ziraat’ sweet cherry cultivar. In this study, different GA3 doses affected significantly (p < 0.05) the most important characteristics of fruit such as fruit weight, fruit firmness and cracking rate determining the marketable value. The lowest and highest fruit weight was 7.95 and 10.02 g in control and 15 ppm GA3 treatments, respectively. Similarly, the lowest and highest fruit firmness was found to be 7.45 and 9.63 N in control treatment and 15 ppm GA3 treatments, respectively. In addition, cracking index of 5.60 and 25.50% was obtained for 20 ppm GA3 and control treatments, respectively. It was also found that GA3 treatments delayed the harvest date for 3 - 4 days and increased the fruit weight by 10.71% in comparison with the control. Furthermore, the application of GA3 decreased the fruit cracking rate by 77.80% in comparison with the control. Fruit colour values were also affected by GA3, application, and brighter and darker red coloured fruits were obtained.

Key words: Sweet cherry, gibberellic acid, cracking index, fruit quality.

INTRODUCTION

There are appropriate climate conditions in Turkey for growing cherry (Prunus avium L.). For this reason, it is among the leading countries in the world for sweet cherry production (Kaşka, 2001, Özçağır et al., 2005, Vursavuş et al., 2006). Turkey has about 18.04% of the world’s sweet cherry production that amounts to 338.361 tons (Anonymous, 2008). Turkey is also the biggest exporter country and meets 23.64% of the world’s sweet cherry exports of 57.019 tons (Anonymous, 2007). The most important factor in the increase of sweet cherry export is that the significant ‘0900 Ziraat’ sweet cherry cultivar whose fruit is large and firm and fruit pedicles are long, is durable in transportation and has lengthy storage (Kaşka 2001; Aşkin et al., 2008).

The increase in the demand for sweet cherry recently has gradually increased the importance of the storage potential and fruit quality. The fruit quality of the sweet cherry may also be affected by some chemical applications before and after the harvest other than the classic cultural applications (Muskovics et al., 2006). The harvest time may change according to ecologic conditions (Gercekcioglu and Polat, 1998) and also the crackings resulting from the rain that happens closer to the harvest time is another significant factor affecting the quality of the sweet cherries (Jedlow and Schrader, 2005; Cline and Trought, 2007). Particularly, in sensitive varieties, the cracking rate goes up to 90% (Simon, 2006). The cracking that causes the fruit to get easily wrinkled may change according to the genetic characteristics of the varieties (Cline and Trought, 2007). Having a thicker cuticula, the ‘0900 Ziraat’ sweet cherry cultivar increases its resistance against cracking (Demirsoy and Bilgener, 1998; Bilgener et al., 1999; Demirsoy and Bilgener, 2000; Kaşka, 2001). Nevertheless, the losses in the marketable fruit quantity resulting from cracking can...
be seen in this cultivar.

For this reason, applications that increase the resistance against cracking are being applied to the varieties that are preferred by the consumers and have good fruit quality. One of the leading applications in the world is chemical substance applications such as gibberellic acid (GA$_3$), Ca, K, NH$_4$ NO$_3$, CH$_2$ and N$_2$ (Demirsoy and Bilgener, 1998; Clayton et al., 2003). Another aim of such applications is also to delay the harvest date and increase the marketing time of those cherries that can not be stored for a long time.

Therefore, this study was conducted to determine the effects of gibberellic acid applications in different doses on the cracking rate and some fruit quality characteristics in the ‘0900 Ziraat’ sweet cherry cultivar, known worldwide as the ‘Turkish Sweet Cherry’.

**MATERIALS AND METHODS**

In this study, the ‘0900 Ziraat’ cultivar grafted onto a 14-year-old wild cherry (Prunus avium L.) rootstock in Uluborlu located in Isparta province was used. GA$_3$ doses were applied to the trees at the rate of 0 (control), 5, 10, 15, 20 and 25 ppm. The applications were made when the fruits were at the straw-yellow stage (about 30-40 days prior to the harvest). Only water was applied to the control trees. Starwet was used as an adhesive spreader. The fruits picked at the harvest time were immediately transported to the post harvest physiology laboratory in ice containers. The measurement of 30 fruits were determined using digital caliper for fruit, seed and pedicel length (mm), fruit and seed width (mm). Fruit and seed weight (g) were determined by a digital scale sensitive to 0.01 g.

Fruit firmness (Newton) was measured by digital penetrometer (Hanna HI221) in three parallel ways. The colour of the fruit was determined with a colorimeter (Minolta Chroma Meter CR-100) using the L$^*$ a$^*$ b$^*$ scale. The cracking index was calculated according to the method of Bilgener et al. (1999). The fruits were harvested in early morning and transported to the laboratory for analyses. The sensibility to fruit cracking was evaluated by immersion of 50 fruits in distilled water at 20°C in 2 L pots for 6 h. The cracked fruits were counted and taken out of the water at intervals of 2 h; the others were immersed in the water again. This practice was repeated 3 times. The cracking index was calculated according to the formula:

$$\text{Cracking index} = (5a + 3b + c) \times 100/250$$

Where, a: Number of cracked fruit after 2 h, b: after 4 h and c: after 6 h; multiplication factor of 5, after 2 h, 3, after 4 h and 1, after 6 h; maximum cracking: 50 x 5 = 250; total number of fruits immersed: 50; multiplication factor of the cracked fruits after the first 2 h was 5.

The experiment was based on randomized blocking pattern as 3 replications and was assigned as one tree at each replication. The data were statistically analyzed using the Statistical Package for the Social Sciences (SPSS) software program according to the variance analyses method. The differences between applications were tested using the Duncan multiple range test.

**RESULTS AND DISCUSSION**

GA$_3$ applications significantly (p < 0.05) increased the fruit weight in the ‘0900 Ziraat’ sweet cherry cultivar. The heaviest fruits (10.02 g) were obtained from the application of 15 ppm GA$_3$ with a 10.71% increased in weight when compared to control (Table 1). Horvitz et al. (2003) showed that GA$_3$ applications delayed the harvest time and significantly contributed to the weight increases. While in this study, a significant difference between applications in terms of fruit width was not observed, the difference in fruit length was significant (p < 0.05). The tallest fruits were obtained from the dose of 20 ppm (25.32 mm) (Table 1). The highest flesh/pit ratio in the study was obtained from 15 ppm GA$_3$ application. The difference in terms of shape index between the applications was not significant (p < 0.05). The fruit size is one of the most important quality parameter in sweet cherry. The demand for sweet cherry is optimum at 10 g fruit weight and 25 mm fruit width as an average (Horvitz et al., 2003). For this reason, as the big fruits are much more flesher, they are preferred more by the consumers (Özkaya et al., 2006; Horvitz et al., 2003; Cline and Trought, 2007). Besides this, it was reported in previous studies that GA$_3$ applications increased cell division and elongation and had a positive effect on fruit sizes (Neil and Cathey, 1960; Looney, 1996; Basak et al., 1998;
Bilgener et al., 1999; Clayton et al., 2003; Horvitz et al., 2003; Usenik et al., 2005; Cline and Trought, 2007). For fruit firmness, there was a statistically significant difference in the GA$_3$ applications ($p < 0.05$). The firmest fruits have been determined from the dose of 15 ppm (9.63 N). The consumer tendencies show that a firm sweet cherry is preferred much more than a soft sweet cherry (Esti et al., 2002; Kappel and MacDonald, 2007; Chauvin et al., 2009).

There are genetic differences between the varieties in terms of fruit firmness. GA$_3$ applications also had a positive effect on increasing the firmness of the sweet cherry fruits (Kappel and MacDonald, 2002; Blazkova et al., 2002; Clayton et al., 2003; Özkaya et al., 2006). In this study, GA$_3$ applications increased seed weight, width and length (Table 1). This increase in the seed weight was statistically significant ($p < 0.05$). It was previously found that GA$_3$ increased both the fruit and seed sizes (Sabir, 1995; Sütyemez, 2000). In this study, it was determined that GA$_3$ applications relatively increased the fruit peduncles in comparison with the control. However, this effect was not statistically significant (Table 1). The sweet cherry becomes deformed more quickly than in other fruits because of the peduncle’s fast water consumption and high respiration (Horvitz et al., 2003). For this reason, a long peduncle is a desired feature in sweet cherry fruits as it extends its shelf-life. It was also reported in previous studies that GA$_3$ had a positive effect on extending the peduncle of the fruit (Patterson and Kupferman, 1983; Sabir, 1995).

No significant differences were found between GA$_3$ applications in terms of SSC and pH values in the ‘0900 Ziraat’ sweet cherry cultivar. Regarding acidity, statistical difference was found between the applications ($p < 0.05$). In this study, GA$_3$ applications had a decreasing effect on the acidity value, the highest acidity was obtained in the control application (0.64%) and the lowest acidity was obtained in the dose of 25 ppm GA$_3$ (0.58%) (Table 2). While some studies showed that GA$_3$ did not have any significant effect on SSC and acidity (Sabir, 1995; Bilgener et al., 1999; Horvitz et al., 2003; Clayton et al., 2003; Usenik et al., 2005; Cline and Trought, 2007), some studies showed that GA$_3$ affected the SSC and acidity values positively or negatively (Sütyemez, 2000; Kappel and MacDonald, 2002; Özkaya et al., 2006; Kappel and MacDonald, 2007).

A statistically significant difference was found between GA$_3$ applications in colour values ($L^*$, $a^*$, $b^*$). $L^*$ value varied between 21.79 (control) and 30.00 (20 ppm). The highest $a^*$ and $b^*$ values were found in 5 ppm GA$_3$ application (24.42 and 7.76, respectively) (Table 2). As a result, brighter and darker red coloured fruits were obtained. Fruit skin colour is important for both fruit quality and fruit maturity (Usenik et al., 2005; Romano et al., 2006; Gunes et al., 2006; Chauvin et al., 2009). The dark colour in fruits is accepted as an important characteristic in terms of the amount of antioxidant substances they contain which has a protective effect against cancer and heart diseases (Romano et al., 2006). For this reason, GA$_3$ applications enable the sweet cherry fruits to have much more red colour, therefore they are preferred more by the consumers (Esti et al., 2002; Özkaya et al., 2006; Romano et al., 2006; Chauvin et al., 2009).

In this study, the preharvest GA$_3$ applications decreased the cracking index in the fruits. The least cracking in the fruit was found in the 20 ppm GA$_3$ application. The most cracking was found in control (25.5%) (Table 3). These results are in line with previous studies which showed that GA$_3$ applications decreased cracking in the fruits (Bilgener et al., 1999; Demirsoy and Bilgener, 2000; Horvitz et al., 2003; Usenik et al., 2005; Cline and Trought, 2007).

The cracking in sweet cherry occurs when it absorbs rain water in the epiderm. In addition, the speed of water intake, skin permeability and fruit turgor have all been considered as factors that may increase the incidence of cracking (Bilgener et al., 1999). Besides the genetic sensitivity of the varieties to cracking, the type of the soil for growing fruit and its humidity affects the incidence of cracking (Simon, 2006). This cracking in the fruit skin causes fruit loss and presents a serious risk for the grower (Demirsoy and Bilgener, 2000; Simon, 2006; Cline and Trought, 2007). It is reported that GA$_3$ applications positively affect the thickness of the epiderm and cuticula layer of the fruit and increases the resistance against cracking (Cline and Trought, 2007).

Table 2. The effect of GA$_3$ doses on fruit chemical characteristics and colour characteristics in the ‘0900 Ziraat’ sweet cherry cultivar.

<table>
<thead>
<tr>
<th>Application (ppm)</th>
<th>SSC (%)</th>
<th>pH</th>
<th>Titrable acidity (% citric acid)</th>
<th>$L^*$</th>
<th>$a^*$</th>
<th>$b^*$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>16.48</td>
<td>3.88</td>
<td>0.64a</td>
<td>21.79c</td>
<td>16.36b</td>
<td>3.65c</td>
</tr>
<tr>
<td>5</td>
<td>16.28</td>
<td>3.92</td>
<td>0.61bc</td>
<td>29.14ab</td>
<td>24.42a</td>
<td>7.76a</td>
</tr>
<tr>
<td>10</td>
<td>16.35</td>
<td>3.87</td>
<td>0.59c</td>
<td>27.31b</td>
<td>20.24ab</td>
<td>5.50b</td>
</tr>
<tr>
<td>15</td>
<td>16.10</td>
<td>3.89</td>
<td>0.63ab</td>
<td>27.73b</td>
<td>21.20a</td>
<td>6.07ab</td>
</tr>
<tr>
<td>20</td>
<td>16.23</td>
<td>3.85</td>
<td>0.60c</td>
<td>30.00a</td>
<td>24.36a</td>
<td>7.59a</td>
</tr>
<tr>
<td>25</td>
<td>16.24</td>
<td>3.86</td>
<td>0.58c</td>
<td>28.44ab</td>
<td>22.10a</td>
<td>7.71a</td>
</tr>
</tbody>
</table>

SSC, soluble solid content. With each column, values followed by the same letter are not significantly different at P = 0.05 level according to Duncan’s multiple range test.
In addition, GA₃ decreases the cracking in fruit by delaying maturity time of fruits and getting over critical rain period (Usenik et al., 2005). As a result, it was observed that the preharvest GA₃ applications had a positive effect on the sweet cherry fruit quality characteristics. Particularly, they delayed the harvest date of 3-4 days which caused an increase in the weight ratio of 10.71%, increased the fruit firmness, helped to obtain darker red coloured fruits with a higher acceptance to the consumer and decreased the cracking rate on the surface of the fruit.

### Table 3. The effect of GA₃ doses on fruit cracking rate in the '0900 Ziraat' sweet cherry cultivar.

<table>
<thead>
<tr>
<th>Application (ppm)</th>
<th>Cracking index (%)</th>
<th>Decrease % in comparison with control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>25.50a</td>
<td>100.00</td>
</tr>
<tr>
<td>5</td>
<td>16.90b</td>
<td>66.60</td>
</tr>
<tr>
<td>10</td>
<td>7.40e</td>
<td>29.20</td>
</tr>
<tr>
<td>15</td>
<td>8.90d</td>
<td>34.90</td>
</tr>
<tr>
<td>20</td>
<td>5.60f</td>
<td>22.20</td>
</tr>
<tr>
<td>25</td>
<td>10.50c</td>
<td>41.07</td>
</tr>
</tbody>
</table>

With each column, values followed by the same letter are not significantly different at P = 0.05 level according to Duncan's multiple range test.

REFERENCES


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