Effects of Preharvest Gibberellic Acid Applications on Fruit Quality of ‘0900 Ziraat’ Sweet Cherry

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SUMMARY. The objective of this study was to determine the effects of gibberellic acid (GA₃) applications on fruit quality of ‘0900 Ziraat’ sweet cherry (Prunus avium), a low cropping and a large-fruited variety. ‘0900 Ziraat’ trees were sprayed with 0, 15, 20, and 25 ppm GA₃, when the fruit were at their straw-yellow color stage. Fruit quality was evaluated at harvest in terms of size, firmness, pedicel length, and soluble solids content (SSC) to determine the optimum application. Fruit treated with GA₃ were significantly larger and firmer than the controls. There were no differences in fruit firmness within the different levels of GA₃ treatment; however, fruit treated with 20 and 25 ppm GA₃ were significantly larger than the fruit treated with 15 ppm GA₃. Trees treated with the optimum concentration of GA₃ (25 ppm) in two different locations yielded fruit with 13.4% and 14.1% greater weight and 38% and 25% higher firmness. GA₃ treatments did not affect pedicel length. The effect of GA₃ application on SSC was complex; there was a significant interaction between GA₃ and location. Being firmer than the controls, the GA₃-treated fruit could be harvested at a later date than the controls.

Sweet cherry is one of the rare nonsurplus fruit in most parts of the world (Esti et al., 2002). Attractive, large, firm, and crack-resistant sweet cherry fruit with long pedicels are desirable to the consumers and are therefore preferred by the growers. Gibberellic acid GA₃ is used to increase the fruit firmness and the fruit size, and to delay maturity in mostly self-fertile and/or high-cropping cherry varieties in British Columbia (Kappel and MacDonald, 2002) and western North America (Looney, 1996); however, its effects on fruit of low-yielding and large-fruited varieties have not been studied.

GA₃ application resulted in variable responses in fruit quality and harvest characteristics of sweet cherry. GA₃-treated sweet cherry fruit were firmer, larger, and heavier compared with controls (Basak et al., 1998; Choi et al., 2002; Clayton et al., 2006; Facteau, 1984, 1986; Facteau et al., 1985a, 1985b; Horvitz et al., 2003; Kappel and MacDonald, 2002; Webster et al., 2006). In contrast to results of Horvitz et al. (2003) and Choi et al. (2002), few researchers have reported that it also increased soluble solid concentration (SSC) (Basak et al., 1998; Lenchan et al., 2006) and the percentage of cherries with long pedicels (Horvitz et al., 2003). GA₃-treated fruit were also firmer at the end of the storage period (Clayton et al., 2003; Ozkaya et al., 2006) and delayed pedicels browning during the storage period (Ozkaya et al., 2006). The response of sweet cherry fruit to preharvest GA₃ application depended on the variety used. Application of GA₃ increased firmness, decreased fruit softening, and delayed maturity for late-maturing genotypes (135–27–17 and ‘Lapins’), but did not increase firmness or delay fruit maturity in early maturing varieties (‘Merpet’ and ‘Celeste’) (Choi et al., 2002). As in the cases of SSC and pedicel length, the response of fruit cracking to GA₃ application was also variable (Basak et al., 1998; Demirsoy and Bilgener, 1998; Looney, 1996; Usenik et al., 2005).

Some of the variable responses of sweet cherries to GA₃ is probably due to environmental factors such as temperature, precipitation, humidity, water status, nutrition, and light (Facteau et al., 1985b) or to the use of different varieties (Usenik et al., 2005). Time of application and dose may also be important. For example, the time of application for variety ‘Bing’ is about 3 weeks before harvest, whereas for ‘Sweetheart’, the straw-yellow developmental stage of fruit is about 5 weeks before the harvest time (Kappel and MacDonald, 2002).

The sweet cherry variety ‘0900 Ziraat’ constitutes about 12% of the world cherry trade (Ergun and Burak, 2001). The most consistent effect of GA₃ application is to increase fruit size and firmness and to delay maturity; however, Demirsoy and Bilgener (1998) reported that GA₃ application 35 d before the harvest date had not increased the fruit size and firmness in ‘0900 Ziraat’ sweet cherry. This is most probably caused by the too early application of GA₃ in the season and at a too early stage of the fruit development. The objective of this study was to determine if the preharvest GA₃ application at the straw-yellow stage (about 21 d before the harvest) of ‘0900 Ziraat’ fruit will increase the fruit size and firmness in this variety, which makes up an important part of the cherry trade in the world.

Materials and methods

The experiments were conducted in 2004 using 6-year-old trees of ‘0900 Ziraat’ sweet cherry in two different locations in Turkey. The first location was an experimental research field of Egirdir Horticultural

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Research Institute located in Egirdir and the second was a commercial orchard in Isparta.

The experiments were designed in a completely randomized design with four single-tree replicates for each treatment. Mature ‘0900 Ziraat’ sweet cherry trees (about 3 m in diameter and grown on Mazzard rootstocks) were sprayed to runoff using a handgun applicator when the fruit were at their straw-yellow stage of development (about 21 d before harvest). The sprays were completed on a nonwindy day in the afternoon between 1700 and 1800 HR. Treatments included a single application of 0, 15, 20, or 25 ppm GA3 (Perplex; Platin Kimya, Istanbul, Turkey). All trees were harvested when the controls were considered to be mature at each location.

For each replication, 80 fruit were sampled randomly to determine the average fruit weight, fruit firmness, SSC, and pedicel length. Fruit firmness was measured at a position located at the fruit’s maximum width using a firmness tester (model FT 001 Fruit Pressure Tester; Gullimex, Alfonshine, Italy) with a 4.94 mm diameter probe.

The pedicels were removed and the juice was obtained by mashing fruit in a plastic bag. The SSC of the fruit juice was determined using a refractometer (model N.O.W. 507-1; Nippon Optical Works, Tokyo) with a 3Brix scale of 0 to 32. Pedicel length was determined using a digital caliper.

Analyses of variance were performed on pedicel length, fruit weight, firmness, and SSC, and then means were subjected to mean separation by Duncan’s multiple range test using SAS (SAS Institute, Cary, NC).

Results and discussion

The effect of GA3 on fruit size and fruit firmness were found to be significant, but no differences were observed between control and treated fruit with respect to pedicel length (Table 1). The effect of preharvest GA3 spray on SSC of the fruit was more complex, and there was a significant interaction between GA3 treatment and location (Table 1).

In Egirdir, the GA3-treated fruit was larger than control fruit (in fruit weight) and there were also significant differences within different levels of the GA3-treated fruit (Table 1). Regardless of the GA3 concentrations, fruit treated with GA3 were larger than the control, and 25 ppm GA3 application yielded larger fruit than other GA3 levels (Table 1). In Isparta, the GA3-treated fruit was also larger than control fruit, but there was no significant difference between 20 ppm and 25 ppm GA3 applications. The largest fruit sizes were obtained from 20 and 25 ppm GA3 applications in Isparta (Table 1). The GA3 application showed similar effects on the mean fruit weight in both locations, and there was no statistically significant interaction between GA3 application and locations with respect to mean fruit weight (Table 1). Trees treated with the optimum level of GA3 (25 ppm) yielded fruit with 13.4% and 14.1% greater weight in Egirdir and Isparta, respectively (Table 1). One of the most important benefits of preharvest GA3 application is a reliable increase of fruit size of about 10% to 15% (Lenehan et al., 2006; Looney, 1996). A similar gain in fruit size as a response to GA3 applications was reported by other researchers (Cline and Trought, 2007; Kappel and MacDonald, 2002; Kupferman, 1989; Lenehan et al., 2006; Ozkaya et al., 2006; Usenik et al., 2005).

When compared with untreated control fruit, all GA3 treatments increased fruit firmness in Egirdir and Isparta (Table 1). No significant differences in fruit firmness were observed among the GA3 levels in either location (Table 1). As in fruit weight, no significant interaction observed between GA3 treatment and location with respect to their effects on fruit firmness and GA3 had the same effect on fruit firmness in either location (Table 1). The result on increased fruit firmness obtained with GA3 applications in this study is consistent with the results of the other researchers (Cline and Trought, 2007; Facteau, 1986; Kappel and MacDonald, 2002; Kupferman, 1989; Lenehan et al., 2006; Ozkaya et al., 2006; Usenik et al., 2005).

The most consistent effects of the preharvest GA3 application are to increase fruit size and firmness and to delay maturity; however, in contrast with our results and with the many others, Demirsoy and Bilgener (1998) reported that GA3 application did not increase the fruit size and firmness in ‘0900 Ziraat’ sweet cherry. Their results are most probably due to the time of application: they applied GA3 35 d before the harvest. This time of application was very early for this variety, and, therefore, potentially ineffective. We have shown that if GA3 is applied later in the season when the fruit was at the straw-yellow stage (about 21 d before the harvest as it is in ‘Bing’ (Kappel and MacDonald, 2002), it was very effective in increasing fruit size and fruit firmness in both of the locations.

Few researchers also observed an increase in SSC as a response to GA3 application (Basak et al., 1998; Lenehan et al., 2006). In our case, the effect of GA3 on SSC was complex (Table 1). The interaction between location and GA3 application was

Table 1. Effects of different levels of gibberellic acid (GA3) applications at the straw-yellow stage on fruit quality (average fruit weight, fruit firmness, pedicel length, and soluble solids) of ‘0900 Ziraat’ sweet cherry in Egirdir and Isparta, Turkey.

<table>
<thead>
<tr>
<th>GA3 treatment (ppm)</th>
<th>Avg fruit wt (g)</th>
<th>Fruit firmness (kg)</th>
<th>Pedicel length (mm)</th>
<th>Soluble solids (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egirdir</td>
<td></td>
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</tr>
<tr>
<td>0</td>
<td>10.32 d*</td>
<td>1.29 b</td>
<td>62.32</td>
<td>19.20</td>
</tr>
<tr>
<td>15</td>
<td>10.80 c</td>
<td>1.79 a</td>
<td>63.02</td>
<td>19.50</td>
</tr>
<tr>
<td>20</td>
<td>11.22 b</td>
<td>1.70 a</td>
<td>63.00</td>
<td>18.13</td>
</tr>
<tr>
<td>25</td>
<td>11.70 a</td>
<td>1.78 a</td>
<td>62.00</td>
<td>19.80</td>
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<td>Isparta</td>
<td></td>
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<tr>
<td>0</td>
<td>8.45 c</td>
<td>1.10 b</td>
<td>48.89</td>
<td>18.43 d</td>
</tr>
<tr>
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<td>9.16 b</td>
<td>1.41 a</td>
<td>49.56</td>
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</tr>
<tr>
<td>20</td>
<td>9.58 a</td>
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<td>50.07</td>
<td>19.32 c</td>
</tr>
<tr>
<td>25</td>
<td>9.64 a</td>
<td>1.37 a</td>
<td>48.53</td>
<td>19.87 b</td>
</tr>
</tbody>
</table>

GA3 × location interactions NS NS NS *

1 ppm = 1 mg L−1; 1 g = 0.0353 oz; 1 kg = 2.0466 lb; 1 mm = 0.0394 inch.

* NS = nonsignificant or significant at P ≤ 0.05.

1 Mean separation by Duncan's multiple range test at P ≤ 0.05.
significant (Table 1); for example, 15 and 20 ppm GA$_3$ sprays resulted in fruit with higher SSC in Isparta, but GA$_3$ had no effect on SSC at any level of GA$_3$ in Egirdir (Table 1). The responses were variable on the effects of GA$_3$ on SSC and there are not always changes in SSC (Facteau et al., 1985b; Kappel and MacDonald, 2002).

It has been reported that GA$_3$ spray increased the percentage of cherries with long pedicels (Horvitz et al., 2003) and delayed the pedicel discoloration during the storage period (Ozkaya et al., 2006). In our study, location was an important factor that effected pedicel length, and fruit had longer pedicel in Egirdir and in Isparta (Table 1). There was no interaction between locations and GA$_3$ treatment regarding pedicel length (Table 1).

In conclusion, the preharvest application of GA$_3$ in the ‘0900 Ziraat’ sweet cherry at the straw-yellow stage increases the fruit size and firmness. Among the concentrations tested, the 25 ppm GA$_3$ application appeared to be the optimum concentration to increase the firmness and fruit size of this variety. Being firmer than the control, GA$_3$-treated fruit can be harvested at a later date than the untreated fruit.

### Literature cited


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