African Journal of Biotechnology Vol. 9(38), pp. 6307-6311, 20 September, 2010
Available online at http://www.academicjournals.org/AJB
DOI: 10.5897/AJB10.747
ISSN 1684–5315 ©2010 Academic Journals

Full Length Research Paper

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

Adnan N. Yildirim* and Fatma Koyuncu

Suleyman Demirel University, Agriculture Faculty, Horticulture Dept., Isparta, Turkey.

Accepted 23 August, 2010

This study was conducted to determine the effects of different gibberellic acid (GA_3) 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 GA_3 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 GA_3 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 GA_3 treatments, respectively. In addition, cracking index of 5.60 and 25.50% was obtained for 20 ppm GA_3 and control treatments, respectively. It was also found that GA_3 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 GA_3 decreased the fruit cracking rate by 77.80% in comparison with the control. Fruit colour values were also affected by GA_3, 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, Özçağıran 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; Aşkın 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 (Gerçekçioğlu and Polat, 1998) and also the crackings resulting from the rain that happens closer to the harvest time is an 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

*Corresponding author. E-mail:adnany@ziraat.sdu.edu.tr. Tel:+90 246 211 46 61. Fax:+90 246 237 16 93.

Table 1. The effect of GA_3 doses on some fruit characteristics in the ‘0900 Ziraat’ sweet cherry cultivar.

Application (ppm)	Fruit weight (g)	Fruit width (mm)	Fruit length (mm)	Shape index	Firmness (N)	Seed weight (g)	Seed width (mm)	Seed length (mm)	Fruit flesh/pit ratio	Peduncle length (mm)
Control	7.95c	24.86	23.60b	0.95	7.45c	0.31c	8.53	11.14	24.38	47.04
5	8.76bc	24.69	24.29ab	0.98	8.56ab	0.32bc	8.54	11.09	26.64	47.61
10	9.42ab	24.79	24.30ab	0.98	9.03ab	0.34bc	8.62	11.28	26.71	48.48
15	10.02a	25.30	24.47ab	0.97	9.63a	0.36a	8.80	11.25	27.13	49.45
20	9.63ab	25.05	25.32a	1.02	8.95ab	0.34ab	8.61	11.30	27.05	49.05
25	9.71a	25.06	24.49ab	0.98	8.16bc	0.34a	8.77	11.25	26.62	49.26

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.

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 world-wide 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 (Lloyd LF Plus). The rates of soluble solid content (SSC) were measured by refractometer (Atago, Japan) and titrable acidity (TA) by titration with 0.1 N NaOH and expressed in percent of citric acid per 100 ml of juice, and pH values were measured with a digital pH meter (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;

Table 2. The effect of GA_3 doses on fruit chemical characteristics and colour characteristics in the '0900 Ziraat' sweet cherry cultivar.

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

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.

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 signi-ficant 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 Mac Donald, 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 (Sabır, 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 consum-ption 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; Sabır, 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 (Sabır, 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 charac-teristic 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 appli-cations positively affect the thickness of the epiderm and cuticula layer of the fruit and increases the resistance against cracking (Cline and Trought, 2007).

Table 3. The effect of GA_3 doses on fruit cracking rate in the '0900 Ziraat' sweet cherry cultivar.

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

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, GA_3 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 GA_3 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.

REFERENCES

Anonymous (2007). Website: http://faostat.fao.org/site/567/default.aspx#ancor.

Anonymous (2008). Website: http://faostat.fao.org/site/535/default.aspx#ancor.

Aşkın MA, Kankaya A, Akinci-Yildirim F, Yildirim AN, Sahin-Cevik M (2008). The Current Situation and Future Prospects of Sweet Cherry Production in Isparta Province of Turkey. Acta Horticult. 795: 541-544.

Basak A, Rozpara E, Grzyb Z (1998). Use of Bioregulators to Reduce Sweet Cherry Tree Growth and to İmprove Fruit Quality. Acta Horticult. 468: 719-723.

Bilgener Ş, Demirsoy L, Demirsoy H (1999). Bazı Kimyasal Uygulamalarının Türkoğlu Kirazında Meyve Çatlaması ve Meyve Kalitesi Üzerine Etkilerinin Araştırılması. Türkiye III. Ulusal Bahçe Bitkileri Kongresi, Eylül, Ankara. pp. 14-17.

Blazkova J, Hlusickova I, Blazek J (2002). Fruit Weight, Firmness and Soluble Solids Content During Ripening of Karesova cv. Sweet Cherry. Horticult. Sci. (Prague), 29(3): 92-98.

Chauvin MA, Whiting M, Ross CF (2009). The Influence of Harvest Time on Sensory Properties and Consumer Acceptance of Sweet Cherries. Horttechnology, 19(4): 748-754.

Clayton M, Biasi WV, Agar IT, Southwick SM, Mitcham EJ (2003). Postharvest Quality of 'Bing' Cherries Following Preharvest Treatment with Hydrogen Cyanamide, Calcium Ammonium Nitrate, or Gibberellic Acid. Hort. Sci. 38(3): 407-411.

Cline JA, Trought M (2007). Effect of Gibberellic Acid on Fruit Cracking and Quality of Bing and Sam Sweet Cherries. Can. J. Plant Sci. 87(3): 545-550.

Demirsoy L, Bilgener Ş (2000). Meyve Çatlamasına Hassasiyet Bakımından Bazı Kiraz Çeşitlerinin Kütikülar ve Epidermal Özellikleri Üzerine Kimyasal Uygulamaların Etkileri. Turk. J. Agric. For. 24(5): 541-550.

Demirsoy LK, Bilgener Ş (1998). The Effects of Preharvest Calcium Hydroxide Applications on Cracking and Fruit Quality in 0900 Ziraat, Lambert and Van Sweet Cherry Varieties. Acta Horticult. 468: 657-662.

Esti M, Cinquanta L, Sinesio F, Moneta E, Di Matteo M (2002). Physicochemical and Sensory Fruit Characteristics of Two Sweet Cherry Cultivars after Cool Storage. Food Chem. 76: 399-405.

Gerçekçioğlu R, Polat M (1998). Tokat Koşullarında Farklı Gelişme Kuvvetine Sahip Anaçlar Üzerine Aşılı Elma Çeşitlerinin Meyve Özelliklerinin Belirlenmesi Üzerine Bir Araştırma. Gaziosmanpaşa Üniv. Ziraat Fakültesi Dergisi, 15(1): 15-29.

Gunes NT, Aygun A, San B (2006). Postharvest heat treatment for enhanced fruit quality during storage of early ripering european Pear. Eur. J. Horticult. Sci. 71(3): 135-142.

Horvitz S, Godoy C, Lopez Camelo AF, Yommi A (2003). Application of Gibberellic Acid to 'Sweetheart' Sweet Cherries:Effect on Fruit Quality at Harvest and During Cold Storage. Acta Horticult. 628: 311-316.

Jedlow LK, Schrader LE (2005). Fruit Cracking and SplittingIn M.D. Whiting (ed) Producing premium cherries. PNW Cherry shortcourse proceedings. pp. 65-66.

Kappel F, MacDonald RA (2002). Gibberellic Acid İncreases Fruit Firmness, Fruit Size and Delays Maturity of 'Sweetheart' Sweet Cherry. J. Am. Pomol. Soc. 56: 219-222.

Kappel F, MacDonald RA (2007). Early Gibberellic Acid Sprays Increase Firmness and Fruit Size of 'Sweetheart' Sweet Cherry. J. Am. Pomol. Soc. 61(1): 38-43.

Kaşka N (2001). Türkiye'nin Sert Çekirdekli Meyvelerde Üretim Hedefleri Üzerine Öneriler. I. Sert Çekirdekli Meyveler Sempozyumu, Yalova. pp. 1-16.

Looney NE (1996). Principles and Practise of Plant Bioregulator Usage in Cherry Production. In Webster AD and Looney NE (eds). Cherries (Crop Physiology, Production and Uses). Cambridge: University Press. pp. 279-298.

Muskovics G, Felföldi J, KovacPerlaki R, Kalay T (2006). Changes in Physical Properties During fruit ripening of hungarian sweet cherry (*Prunus avium* L.) cultivars. Postharvest Biol. Technol. 40: 56-63.

Neil S, Cathey HM (1960). Applied Aspects of The Gibberellins. Ann. Rev. Plant Physiol. 12(1): 369.

Özçağıran R, Ünal A, Özeker E, İsfendiyaroğlu M (2005). Ilıman İklim Meyve Türleri. Sert Çekirdekli Meyveler Cilt-I. ISBN: 975-483-580-2. Ege Üniversitesi Ziraat Fakültesi Yayınları İzmir. 553: p. 229.

Özkaya O, Dündar Ö, Küden A (2006). Effect of preharvest gibberellic acid treatment on postharvest quality of sweet cherry. J. Food, Agric. Environ. 4(1): 189-191.

Patterson ME, Kupferman E (1983). CA Storage of 'Bing' cherries. Postharvest Pomol. Newslett. 1(2): 7-12.

Romano SG, Cittadini DE, Pugh B, Schouten R (2006). Sweet Cherry Quality in the Horticultural Production Chain. Stewart Postharvest Rev. 6(2): 1-9.

Sabır E (1995). Salihli ve Noble Kiraz Çeşitlerinde Hasat Öncesi GA3 Uygulamalarının Depolama ve Meyve Kalitesine Etkileri Üzerinde Araştırmalar. Ege Üniversitesi Fen Bilimleri Enstitüsü. p. 79.

Simon G (2006). Review on rain induced fruit cracking of sweet cherries (*Prunus avium* L.), İts Causes and the possibilities of prevention. Int. J. Horticult. Sci. 12(3): 27-35.

Sütyemez M (2000). Bazı Kiraz Çeşitlerinde GA_3 Uygulamalarının Meyve Tutum ve Meyve Kalitesi Üzerine Etkileri. Fen ve Mühendislik Dergisi, 3(1): 43-50.

Usenik V, Kastelec D, Stampar F (2005). Physicochemical Changes of

Sweet Cherry Fruits Related to Application of Gibberellic Acid. Food Chem. 90: 663-671.
Vursavuş K, Kelebek H, Selli S (2006). A Study on Some Chemical and Physico-Mechanic Properties of Three Sweet Cherry Varieties (*Prunus avium* L.) in Turkey. J. Food Eng. 74: 568-575.