Size and Weight of Sweet Cherry (*Prunus avium* L. 'Regina') Fruit Treated with 3,5,6-TPA and GA3

Silvija ZEMAN [1] (✉)
Zlatko ČMELIK [2]
Tomislav JEMRIĆ [2]

Summary

The effect of 10 ppm 3,5,6-TPA (3,5,6-trichloro-2-pyridyloxyocetic acid), 20 ppm GA 3 and their combination on size and weight of cherry fruit (*Prunus avium* L. 'Regina') were studied. 3,5,6-TPA was applied 25 days after full bloom and GA 3 during stage of fruit color change from green to straw-yellow. Fruit height, width, thickness and weight were measured. Width, thickness and weight of control fruit were the smallest. Fruit from 3,5,6-TPA - treated trees did not show significant difference in comparison to control. However, fruit from GA 3 – treated trees had significantly improved all characteristics in comparison to control fruits. Weight of fruit from trees treated with combination of 3,5,6-TPA and GA 3 was 14% higher than control fruit and 2.8% higher than fruit from GA 3 - treated trees, but there was no significant difference comparing to fruit from trees treated with GA 3 alone. These results are preliminary results after a one-year study and more research should be done to examine the possible influence of other factors, such as ecological factors, before final management recommendations could be made.

Key words

Prunus avium L., fruit quality, plant growth regulators

[1] Bioinstitute, Rudolfa Steinera 7, 40000 Čakovec, Croatia
✉ e-mail: silvija@bioinstitut.hr
[2] University of Zagreb, Faculty of Agriculture, Department of Pomology, Svetošimunska 25, 10000 Zagreb, Croatia

Received: July 27, 2011 | Accepted: September 14, 2011

Introduction

Small fruit size is one of limiting factors for fruit quality in many fruit species, such as apple (Stern et al., 2006), pear (Stern and Flaishman, 2003), sweet cherry (Whiting and Ophardt, 2005; Sansavini and Luigi, 2005), peach (Agusti et al., 1994), and apricot (Agusti et al., 1999). Fruit size can be enlarged by application of growth regulators such as synthetic auxines and gibberelines.

Synthetic auxins can improve fruit growth if they are applied in second fruit growth stage (Westwood, 1993). It is known that synthetic auxsines contribute to cell enlargement (Westwood, 1993; Davis, 2004), and fruit enlargement in some fruit species like clementine (Augusti et al., 1995), peach (Augusti et al., 1999), litchi (Stern et al., 2000), apricot (Augusti et al., 1994) and sweet cherry (Stern et al., 2007).

Auxine application at the beginning of pit hardening in plum cv. Sonagold increases intake of carbohydrates or elasticity of cell wall causing significant cell enlargement (Arteca, 1996). Use of GA 3 and auxine combination can reduce puffing in tomato fruit (Yamasaki et al., 1961) and enhance fruit weight in high temperature conditions (Sasaki et al., 2005). This treatment can also increase sugar content (mostly hexose content), which results in increased fruit weight (Kataoka et al., 2009). GA 3 application before harvest in peach (Amarante et al., 2005), tangerine (Marur et al., 1999) and sweet cherry (Kappel and MacDonald, 2002; Usenik et al., 2005) can prolong ripening and in some cases increase fruit size.

Treating of peaches with GA 3 at the beginning and ending of pit hardening prolongs ripening, increases fruit size and decreases woollines during cold storage (Pegoraro et al., 2010).

GA 3 application in sweet cherries improves fruit quality and decreases negative effect of rain or early harvest (Lonney, 1996), increases fruit weight (Faust, 1989) and delays maturation (Demirsoy and Bilgener, 2000). Delaying of maturation is of special importance for late cultivars (Choi et al., 2002), and GA 3 - treated fruit is bigger in size and more firm than untreated ones (Kappel and MacDonald, 2002).

To the best of our knowledge, there were no published studies in the available literature concerning combined effects auxines and gibberelines in inner or outer characteristics of sweet cherry fruit, so the aim of this paper is to determine how much auxines, gibberelines and their combination affect thickness, width, height or weight of cherry fruit.

Material and methods

Trials are done in Međimurje (Donji Kraljevec) on 'Regina' cultivar on 'Gisela 5' rootstock. Cultivar 'Regina' was chosen because of its appropriate characteristics and appropriate ripening time suitable for the growing area. In trial orchard fruit trees are planted at 4 x 2.5 m apart (1000 trees/ha). Trial was set at complete randomized design with five trees for each of four treatments (control; 3,5,6-TPA; GA 3; GA 3 and 3,5,6-TPA combined). 3,5,6-TPA was applied in concentration of 10 ppm 25 days after full bloom, GA 3 was applied in concentration of 20 ppm during stage of fruit color change from green to straw-yellow. Ten fruits were picked from each tree and their width, height and thickness were measured by digital caliper and weight was measured by Mettler-Toledo analytical scale.

Statistical data analysis was done using PROC GLM in SAS (SAS Institute, 2004) using analysis of variance (ANOVA) and Tukey HSD test at $P \leq 0.05$ level.

Results and discussion

Fruit size and weight data are given in Table 1. Width, thickness and weight in control were the smallest while 3,5,6-TPA treatment did not show significant increase in characteristics mentioned before. Stern et al. (2007) reported that auxin treatment speeds up fruit growth only 3-4 days after application.

As a contrast, GA 3 application significantly increased all characteristics in comparison to control. GA 3 increases total soluble solids, fruit weight, skin color and prolongues maturation time (Usenik et al., 2005). Fruits treated with 20 ppm GA 3 are significantly bigger in size than untreated or ones treated with 30 ppm GA 3 (Kappel and MacDonald, 2002).

Application of combination of 3,5,6-TPA and GA 3 showed trend of further increase of all characteristics, but the difference was not significant compared to application of GA 3 alone. Weight of fruit treated with combination of 3,5,6-TPA and GA 3 showed 14% increase compared to control and 2.8% increase compared to fruit treated with GA 3 alone. Similar results are achieved in tomatoes with 50 mg GA 3 added to auxine solution applied during the anthesis. It increased fresh fruit weight for 13.18% (Kataoka et al., 2009).

Conclusion

Results of this research showed that independent application of GA 3 during the stage of fruit color change to straw-yellow was sufficient for significant increase in size and weight of sweet

Table 1. The effect of 3,5,6-TPA, GA 3 and their combination of fruit size and weight of sweet cherry 'Regina' (means and SD)

Treatment	Width (mm)	Thickness (mm)	Height (mm)	Weight (g)
Control	24.22±1.50 c	21.53±1.19 c	22.38±1.26 b	7.62±0.93 c
3,5,6-TPA	24.68±1.63 bc	22.06±1.26 bc	22.51±1.28 b	7.81±1.22 bc
GA 3	25.19±1 25 ba	22.32±0.94 ba	2299±1.26 ba	8.44±1.57 ba
3,5,6-TPA and GA 3	25.66±1.61 a	22.77±1.18 a	23.28±1.32 a	8.67±1.42 a

Note: means followed with the same letter in the same column are not significantly different at $P \leq 0.05$ according to the Tukey HSD test

cherry fruit. These results are preliminary after a one-year study and more research should be done to examine the possible influence of other factors, such as ecological factors, before final management recommendations could be made.

References

Agusti, M., Almela, V., Andreu, I., Juan, M., Zacarias, L. (1999). Synthetic auxin 3,5,6-TPA promotes fruit development and climacteric in *Prunus persica* L. Batsch. J Hortic Sci Biotechnol 74:556–660

Agusti, M., El-Otmani, M., Juan, M., Almela, V. (1995). Effect of 3,5,6-trichloro-2-pyridyloxyacetic acid on clementine early fruitlet development and on fruit size at maturity. J Hortic Sci 70:955–962

Agusti, M., Juan, M., Almela, V., Speroni, C. (1994). The effect of 2,4-DP on fruit development in apricots (*Prunus armeniaca* L.). Sci Hortic 57: 51–57

Amarante, C. V. T. D., Drehmer, A. M. F., Souza , F. D., Francescatto, P. (2005). A pulverizacao pre-colheita com acido giberelico GA 3 e aminoetoxivinilglicina (AVG) retarda a maturacao reduz as perdas de frutos na cultura do pessegueiro. Res Bras Frutic 27: 1-5

Arteca, R. N. (1996). Plant growth substances : Principles and applications, Chapman and Hall Press, New York, USA, pp 332

Choi., C., Wiersma, P. A., Toivonen, P. I., Kappel, F. (2002). Fruit growth, firmness and cell wall hydrolytic entyme during development of sweet cherry fruit treated with gibberellic acid GA 3. J Hortic Sci Biotechnol 77:615-621

Davis, P. J. (2004). The plant hormones: their nature, occurrence and functions. In: Davis, P.J. (Ed.), Plant Hormones. Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 1–15

Demirsoy, L., Bilgener, S. (2000). The effect of chemical applications on cuticular and epidermal properties of some sweet cherry cultivars with respect to fruit cracking susceptibility. Turk J Agric For 24:541-550

Faust, M. (1989). Physiology of temperate zone fruit trees. Wiley, New York ,USA , pp 169-234.

Kappel, F., MacDonald, R. A. (2002). Gibberellic acid increases fruit irmness, fruit size, and delays maturity of sweetheart sweet cherry. J Am Pomolog Soc 56:219-222

Kataoka, K., Yashiro, Y., Habu, T., Sunamoto, K., Kitajima, A. (2009). The addition of gibberellic acid to auxin solutions increases sugar accumulation and sink strength in develo-pong auxin-induced parthenocarpic tomato fruits Sci Hort 123:228-233

Looney, N. E. (1996). Principles and practice of plant bioregulator usage in cherry production In: A. D. Webster and N. E. Looney (Eds.), Cherries: Crop physiology, production and use, Cambridge University press, pp 279-298

Marur, C. J., Stenzel, N. M. C., Rampazzo, E. F., Scholz, M. B. S. (1999). Acido giberelico GA 3 e maturacao de frutos das tangerinas. Mexerica Montenegrina Ponca Sci Agric 56:517-521

Pegoraro, C., Zanuzo, M. R., Chaves, F. C., Brackmann, A., Girardi, C. L., Lucchetta, L., Nora, L., Silva, J.A. , Rombaldi, C. V. (2010). Physiological and molecular changes associated with prevention of woollines in peach following pre-harvest application of gibberellic acid. Postharvest Biol Tec 57: 19-26

Sansavini, S., Lugli, S. (2005). Trends in sweet cherry cultivars and breeding in Europe and Asia. In: Proc. 5th Int. Cherry Symposium. Bursa, Turkey, (Abstract), p. 1

SAS Institute (2004). SAS/STAT® 9.1 User's Guide. SAS Institute Inc., Cary, NC.

Sasaki, H.,Yano, T.,Yamasaki, A. (2005). Reduction oh high temperature inhibition in tomato fruit set by plant growth regulators. Jpn Agric Res Quart 39:135-138

Stern, R. A., Flaishman, M., Applebaum, S., Ben-Arie, R. (2007). Effect of synthetic auxins on fruit development of ‚Bing' cherry (*Prunus avium* L.). Sci Hortic 114:275-280

Stern, R. A., Stern, D., Harpaz, M., Gazit, S. (2000). Applications of 2,4,5-TP 3,5,6-TPA and combinations thereof increases lychee fruit size and yield. HortSci 35: 661–664

Stern, R. A., Ben Arie, R., Applebaum, S., Flaishman, M. (2006). Cytokinins increase fruit size oh Delicious and Golden Delicious apple in warm climate. J Hort Sci Biotech 81:51-56

Stern, R. A., Flaishman, M. A. (2003). Benzyladenine effects on fruit size ,fruit thinning and return yield of Spadona and Coscia pear. Sci Hort 98:499-504

Usenik,V., Kastelec, D., Štampar, F. (2005). Physicochemical changes of sweet cherry fruits related to application of gibberellic acid. Food Chem 90: 663-671

Westwood, M. N. (1993). Temperate-Zone Pomology: Physiology and Culture, third ed. Timber Press, Portland, OR, USA, pp 523

Whiting, M. D., Ophardt, D. (2005). Comparing novel sweet cherry crop load management strategies. HortSci 40:1271–1275

Yamasaki, K., Hori, Y., Higashi, T. (1961). The effects of artificial pollination and gibberellin treatment on the occurrence of puffy fruits in tomato growing. Res. Bull. Hortic. Stat. National Tokai-Kinki Agric Res Cent Jpn 6:38-48 (english abstract)

acs77_10