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The Influence of a Cytokinin-Containing Bio-Stimulant on Fruit-Stem Removal Force and Quality Attributes in Cherries

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Abstract

Production of cherries with large fruit size, rich color and high firmness is extremely critical in today's competitive market. The influence of Foliar TRIGGRR® (TRIGGRR®), a cytokinin-containing compound, on fruit quality attributes of 'Bing', 'Chelan', and 'Lapin' cherries were studied under climate conditions of Intermountain West region in Southwest Idaho, USA. TRIGGRR® reduced fruit-stem removal force, fruit firmness, and soluble solids in 'Bing' cherry. However, application of TRIGGRR® significantly improved fruit color but did not have any effect on fruit weight, firmness, or soluble solids concentration in 'Chelan' cultivar. TRIGGRR® significantly improved fruit quality of 'Lapin' cherry by enhancing fruit size, fruit-stem removal force, and firmness. Thus, the application of this compound on 'Chelan' and 'Lapin' cultivars is recommended, as fruit from this region is mostly exported to far destinations, and fruit with higher rigidity and firmness can withstand damages and bruising during the transportation. Studying potential synergism or antagonism effect of TRIGGRR® with other growth regulators in cherries is strongly recommended.

Keywords: Cherries; Cytokinin; Chelan; Lapin; Triggrr; Soluble solids; Firmness; Bing; Gibberellic acid; Rootstock

Introduction

There is an increase in the world sweet cherry (Prunus avium L.) production [1]. According to a recent figure, United State produced 35,208 ha of sweet cherries, of which 21,448 ha was produced in the Pacific Northwest (PNW) region [2]. Fruit size is the most important attribute in sweet cherry and rootstock and scion genetics, crop load, and environmental factors each affect final fruit size and quality [3-5]. Bio-stimulants and growth regulators, with or without hormonal action, have been used in the past decades, to improve fruit quality attributes in apples [6] and cherries [7]. Zheng and Whiting [7] screened 8 plant growth regulators, including cytokinins, gibberellins, and auxins, and their combinations for their ability to increase 'Bing' fruit weight. Among growth regulators and bio-stimulants, gibberellic acid (GA3) is the most studied compound in cherries, and application of this compound during the stages II–III transition increased fruit size and delayed maturation [5-12]. Despite the importance of fruit size and potential role of growth regulators on fruit size, limited attention has been given to the impact of cytokinin-containing compound on cherries. Thus, the objective of this project was to study the impacts of TRIGGRR®, a cytokinin-containing product, on fruit quality and maturity attributes of three cherry cultivars in the Intermountain West of the United States.

Materials and Methods

An orchard of 'Bing', 'Lapin', and 'Chelan' cherry was selected in Sunny Slope, Idaho. The orchard for each cultivar was 18-years old, and trees were grafted on 'Mahaleb' (Prunus mahaleb) rootstock and planted at a 4 x 6 m spacing. The soils in all orchards were sandy loam with a pH of about 7.5. Trees were mature and had a full production at the time of this study. General cultural practices in these orchards were similar to those recommended for the Pacific Northwest region [13]. Foliar TRIGGRR® (referred to as TRIGGRR® throughout this article) is a bio stimulant, containing cytokinin as kinetic a.i. at 0.0173%, manufactured and distributed by Westbridge Agricultural Products, Vista, CA, USA. In our study, TRIGGRR® at a rate of 2343 mL formulation per hectare was sprayed with an air blast sprayer on eight rows of trees in each cultivar (Figure 1). Four to five rows between the

adjacent sprayed rows were not sprayed with Foliar TRIGGRR® and were used as un-treated control. We made sure that no spray drift was landed on un-treated control trees. In each cultivar, we had eight rows (replications) for each of the sprayed and un-treated control. Each replication consisted of five trees. The tree rows with Foliar TRIGGRR® treatment received this chemical at four developmental stages as follows:

a) At first sign of white of bloom.

b) At petal fall.

c) At first sign of "straw" color (same timing as GA application).

d) At about two weeks prior to harvest.

Figure 1: 'Chelan' cherries treated with TRIGGRR®.

At commercial harvest, 10 fruit from each of the five experimental trees were sampled, making a composite sample of 50 fruit per replication. Each composite fruit sample was put in a zip logged bag and transferred to the laboratory in ice chests, containing ice. Fruits were weighed and color was rated visually on a scale of 1 = 20% colored, progressively to 5=100% colored. Fruit-stem removal force on each cherry fruit was measured with a fruit-stem removal tester (Figure 2) and fruit firmness was measured using a firmness tester (Figure 3). Pits were removed and fruit were crushed, and the soluble solids concentration (SSC) was measured by placing three to four drops of juice on a handheld temperature-compensated refractometer (Atago N1, Tokyo, Japan) harvest. The experimental design was a randomized complete block with eight composite replications. Assumption of normality was checked by computing univariate analyses for all treatments of this study. All data were normally distributed including percentages of sunburn rates. Data were analyzed by general linear analysis (GLM), using a t test and LSD mean separation ($P \leq 0.05$), using SAS (SAS Institute Inc., Cary, N.C.).

Figure 2: Measuring cherry fruit-stem removal force.

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Figure 3: Measuring cherry fruit firmness.

Result and Discussion

The results varied among cultivars of cherry. In 'Bing' cherry, application of TRIGGRR® did not influence fruit weight with or without stem and fruit color (Table 1). However, TRIGGRR® spray significantly reduced fruit-stem removal force, fruit firmness, and soluble solids of 'Bing' cherry (Table 1). The reduction of firmness suggests that TRIGGRR® enhanced maturity in 'Bing' cherry. Reduction of fruit firmness, fruit-stem removal force, and soluble solids are negative quality criteria because our sweet cherries are exported to several countries. Shipping in containers to foreign destinations takes a few weeks of journey on the sea. Although the containers are refrigerated, fruit with lower fruit firmness and fruit-stem removal force will have shorter life during shipment. Application of TRIGGRR® significantly improved fruit color in 'Chelan' cheery (by 10%) but did not have any significant effect on fruit weights with or without stem, firmness, or fruit soluble solids concentration (Table 2). TRIGGRR® significantly improved fruit quality of 'Lapin' cherry by enhancing fruit size, with and without stem, by about 23% and by increasing fruit-stem removal force by 30% and fruit firmness by 14% (Table 3). Based on this study, the impact of TRIGGRR® on 'Bing' is different than on the other cultivars. Application of this chemical on 'Chelan' and 'Lapin' is extremely beneficial as it improves fruit firmness and fruit-stem removal force in 'Lapin' and fruit color in 'Lapin'. Cherries in Idaho are harvested a few weeks after cherries in California and exported to long distances overseas. Also, cherries in Idaho are grown in mountainous areas of the Intermountain West that has long and warm days and cool nights during cell expansion, development, and ripening. Photosynthate produced during daytime will be used for much richer pigment and flavor components than cherries produced in areas with low elevations and warmer nights. Cherries with higher firmness and fruit-stem removal force are more resilient during shipment and reach their destinations with less bruising and with more storage and shelf life. Further studies are warranted on the impacts of different concentrations of TRIGGRR®, in combination with other bio stimulants and growth regulators. For example, combination of GA3 with TRIGGRR® could induce a synergistic effect and, consequently further increase fruit size. Maintaining high fruit-stem removal force and firmness in sweet cherries is of paramount and must be the main focal point of any study involving a combination of growth regulators. Also, combination of growth regulators could create an antagonistic effect on certain quality attributes in cherries and thus, adversely affect storage life and shipment ability of fruit (Fallahi, unpublished data). The combination of dwarfing rootstocks with various tree canopy architectures has enabled cherry growers to establish high density orchards with increased production per unit of land. However, production of smaller fruits in trees on modern dwarfing rootstocks may require application of blossom thinners. Studying the potential interactions between these blossom thinners with TRIGGRR® also needs to be further investigated.

Table 1: Effect of TRIGGRR® on fruit quality of 'Bing' cherry, Sunny Slop, Idaho.

Treatment	Weight with Stem (g)	Weight Without Stem (g)	Color (1-5)[z]	Fruit-Stem Force	Firmness (g)	Soluble Solids Concentration (°Brix)
Control	10.26 a[y]	10.10 a	4.73 a	880 a	456 a	19.96 a
TRIGGRR®	9.42 a	9.32 a	4.82 a	795 b	378 b	17.44 b

[z] Fruit color rating: 1= green progressively to 5= dark marron.
[y] Values followed by the same letter within the same column are not significantly different at 5% level.

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Table 2: Effect of TRIGGRR® on Fruit Quality of 'Chelan' cherry, Sunny Slop, Idaho.

Treatment	Weight with Stem (g)	Weight Without Stem (g)	Color (1-5)[z]	Fruit-Stem Force (g)	Firmness (g)	Soluble Solids Concentration (oBrix)
Control	5.12 a[y]	5.01 a	4.40 b	478 a	436 a	14.28 a
TRIGGRR®	5.74 a	5.64 a	4.85 a	534 a	326 a	14.08 a

[z] Fruit color rating: 1= green progressively to 5= dark marron.
[y] Values followed by the same letter within the same column are not significantly different at 5% level.

Table 3: Effect of TRIGGRR® on Fruit Quality of 'Lapin' cherry, Sunny Slop, Idaho.

Treatment	Weight with Stem (g)	Weight without Stem (g)	Color (1-5)[z]	Fruit-Stem Force (g)	Firmness (g)	Soluble Solids Concentration (oBrix)
Control	9.02 b	8.91 b	4.62 a	473 b	374 b	16.60 a
TRIGGRR®	11.18 a	10.97 a	4.65 a	615 a	425 a	16.4 a

[z] Fruit color rating: 1= green progressively to 5= dark marron.
[y] Values followed by the same letter within the same column are not significantly different at 5% level.

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