The Effects of AVG and Harpin Treatments on Fruit Set of '0900 Ziraat' Sweet Cherry

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ABSTRACT

The '0900 Ziraat' with superior fruit characteristics is an important sweet cherry cultivar of Turkey. However, the cultivar has poor fruit set problem. The present study was conducted to investigate the effects of AVG and Harpin applied at the beginning of flowering period on fruit set of '0900 Ziraat ' sweet cherry. Current findings revealed that 250 mgL^{-1} Harpin or 500 mgL^{-1} AVG treatments significantly increased fruit set ratios. While 250 mgL^{-1} AVG and 125 Harpin doses alone were not found to be efficient, they significantly improved fruit set ratios whey they were applied together. While AVG treatments did not change fruit characteristics significantly, both 125 mgL^{-1} and 250 mgL^{-1} Harpin treatments decreased fruit size, fruit flesh firmness, stem retention force (SRT) and soluble solids content (SSC) and induced skin color development.

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1. INTRODUCTION

Fruit set in sweet cherry may vary based on cultivars. While excessive fruit set is observed in some cultivars, quite low fruit set levels may be experienced in some others. For instance, low fruit set ratios were reported for 'Kordia' and 'Regina' cultivars in several regions of Australia [1] In Turkey, '0900 Ziraat' with superior fruit characteristics has quite significant commercial value. On the other hand, although varied based on the region of culture and the rootstock used, this cultivar generally exhibit low fruit set ratios. Cross pollination is essential in self-incompatible cultivars like '0900 Ziraat' to ensure sufficient fruit yields. Low fruit set is usually related to unfavorable environmental conditions for pollinator activity and yields may vary significantly from year to year [2], [3].

It was indicated in previous studies that pollination efficiency could be increased through extending stigma receptive period and thus improving fruit set [4], [5].

Premature abortion of the ovule was reported as the greatest reason for low fruit sets in Bing cherry cultivar [6].

Ethylene was reported to have significant roles in abscission and senescence of flower [7]. It has been found that AVG, an ethylene inhibitor, prolonged stigma receptive period and thus improved yield levels of cherry cultivars [1].

Harpin isolated from the bacterial pathogen *Erwinia amylovora* was known to stimulate plant defense mechanism. In addition, exogenous application of harpin has been claimed to have significant impacts on plant growth and yield [8], [9].

There are not any studies in literature about the effects of Harpin on yield and fruit set of fruit cultivars, but it was reported in some other previous studies that external Harpin treatments significantly increased fruit set and yields in some vegetable cultivars [10],[11].

In the light of above mentioned literature, the present study was conducted to investigate the effects of alone and combined AVG and Harpin treatments on fruit quality and fruit set of '0900 Ziraat' cherry cultivar.

2. MATERIALS AND METHODS

The study was carried out in a commercial orchard of '0900 Ziraat' located in Suşehri town in Kelkit Valley in 2015. Trees were grafted on 'MaxMa 14' rootstocks and trained to Spanish Bush System, with a planting spacing of 4 m x 3.5 m. Fifty six 5 years-old trees were selected and grouped into six blocks of 9 trees. Selected trees were uniformly sprayed with an aqueous solution containing active ingredient Harpin (125 or 250 mgL^{-1}) (as Messenger Gold) or AVG (250 or 500 mgL^{-1}) (as Retain), or their combination (125 mgL^{-1} Harpin + 250 mgL^{-1} AVG, 125 mgL^{-1} Harpin + 500 mgL^{-1} AVG, 250 mgL^{-1} Harpin + 250 mgL^{-1} AVG, or 250 mgL^{-1} Harpin + 500 mgL^{-1} AVG). For each treatment, a tree was used in each block and one tree in each block received no treatment and served as control (only 0.05% v/v of Sylgard 309).

Sprays were applied to whole trees until run-off with a low pressure hand sprayer at 10% bloom. Then two limps were tagged per tree and flowers per limp were counted at full bloom. Tagged limps

were harvested at commercial harvest date and the number of fruits per limp was recorded. Then, fruit set ratios (the number of fruits x 100/ the number of flowers) were calculated.

Fifty fruits from per tree were randomly collected at commercial harvest and used fruit quality measurements. Fruit diameters were measured at the widest point of the fruit using a digital caliper and expressed as fruit size. Skin color and flesh color was assessed using the color chart developed by the Centre Technique Interprofessionnel des Fruits et Légumes (CTIFL). This prototype chart provides a range of red color chips numbered from 1 to 8, with 1 being a light pink-red and 8 being a very dark red. A 20-ml juice sample was titrated with 0.1 N NaOH to pH of 8.1 and titratable acidity (TA) was expressed as grams of malic acid per 100 ml^{-1} of juice. Soluble solids concentration (SSC) was measured by using a digital refractometer (PAL-1, McCormick Fruit Tech., Yakima, Wash). Fruit firmness was determined in terms of the maximum force (N) that is needed to penetrate the fruit vertically. Measurements were carried out by the universal test device Zwick Z0.5 (Zwick/Roell Z0.5, Germany), a device that can apply force up to 500 N and has a 1.8 mm thick stainless-steel tip, at a speed rate of 0.5 mm/s and maximum 10 mm deep into the fruit. Stem retention force (SRF) was measured using a Tronic SH-50 digital force gauge.

The experiment was laid out in a randomized complete block design with six blocks (replicate), each consisting of nine trees. Each experimental plot contained a single tree. Data were analyzed by analysis of variance and means separation was carried out using Duncan's Multiple Test. All analyses were conducted using the SAS statistical package (SAS Institute, Cary N.C.).

3. RESULTS

While AVG treatments alone did not result in significant changes in fruit size, Harpin alone and in combination with AVG resulted in a slight decrease in fruit size. While Harpin alone treatments or 125 mgL^{-1} Harpin + 250 mgL^{-1} AVG combined treatment decreased fruit firmness, other treatments did not cause in significant changes in fruit firmness compared to control treatment. Both doses of single Harpin treatments (125 and 250 mgL^{-1}) increase skin color. Compared to control treatments, single AVG treatments and combined treatments of both growth regulators (AVG + Harpin) did not have

any significant effects on skin color. There were not any significant differences in fruit flesh color and titratable acidity among treatments. Soluble solid content of the fruits from both 125 and 250 mgL^{-1} Harpin treated fruits were lower than the Soluble solid content of the fruits from control trees. The Soluble solid content of the fruits from single AVG or AVG + Harpin combination treated trees were not significantly different from the Soluble solid content of the fruits from control trees. Stem retention force was not affected by AVG and AVG + Harpin treatments. On the other hand, single Harpin treatments significantly decreased stem retention forces (Table 1).

While 125 mgL^{-1} Harpin and 250 mgL^{-1} AVG treatments did not result in significant changes in fruit set, 250 mgL^{-1} Harpin and 500 mgL^{-1} AVG treatments significantly increased fruit set ratios. The fruit set ratio of 8.2% in control treatment reached to 19.6 % and 21.0% respectively with 250 mgL^{-1} Harpin and 500 mgL^{-1} AVG treatments. Although single AVG dose of 250 mgL^{-1} and Harpin dose of 125 mgL^{-1} seemed to be ineffective alone, a distinctive increase was observed in fruit set when these two doses were applied together. Compared to control treatment, other doses of combined AVG and Harpin treatments also resulted in higher fruit set ratios (Figure 1).

4. DISCUSSION

Current findings revealed that fruit set in '0900 Ziraat' cherry cultivar could be improved with AVG treatments. The present findings comply with the results of previous studies carried out with other cherry cultivars [1] and other fruit species [12], [13], [14], [15] about the effects of AVG treatments. [1] reported that the lower doses of AVG (about 75-150 mgL^{-1}) were effective in fruit set of 'Kordia' and Regina sweet cherry. In present study, the AVG dose of 250 mgL^{-1} was not found to be sufficiently effective, but 500 mgL^{-1} AVG dose yielded a remarkable increase in fruit set. This situation indicated that efficient AVG dose might vary depending on cultivars.

With regard to fruit set, the respond of '0900 Ziraat' cherry cultivar to Harpin treatments were similar to responds to AVG treatments. Considering the effects of these growth regulators on ethylene synthesis, such a similarity seemed to be inconstant. Although [16] reported retarded ethylene synthesis with postharvest Harpin treatments in winter jujube fruits, it was generally indicated that Harpin treatments

induced ethylene synthesis [16]. On the other hand, improving impact of Harpin on fruit set may be through expansin proteins. [16] reported induced expansin protein production with Harpin treatments. [17] indicated that expansin proteins released by pollens in some grass plants softened cell wall material and facilitated penetration of pollen tube into the stigma. Although there were not any studies in literature directly focusing on the effects of Harpin on fruit set of different fruit species, increased fruit set ratios were reported by [10] in tomato, [8] in melon and by [11] in pepper. Although lower doses of single AVG and Harpin treatments were not effective, they increased fruit set ratios significantly when they were applied together. This result points out a possible synergic effect of these two growth regulators.

[1] working on Regina and Kordia reported that responses in terms of fruit size, flesh firmness and stem retention force elicited by AVG treatments at flowering period were dependent on cultivars. In present study, AVG treatments did not cause significant differences in fruit characteristics relative to control treatment.

[18] reported that Harpin treatments at pit-hardening period or 21 days after pit hardening increased fruit sizes in peaches. In present study, Harpin treated at flowering period resulted in smaller fruit sizes in '0900 Ziraat' sweet cherry. Current findings revealed that harpin treatment could induce fruit ripening by decreasing fruit flesh firmness and stem retention force, and increasing skin color development. This activity of harpin may be related to its effect on expansin proteins. It was reported in previous studies that external Harpin treatments induced expansin protein formation [9] and expansin proteins distorted cell wall structure and resulted in fruit softening [19]. On the other hand, Harpin treatments decreased Soluble solid content. This was contradict with activity of harpin inducing ripening. It was concluded in this study that AVG or Harpin could be used to improve fruit set in '0900 Ziraat' sweet cherry cultivar and combined treatments may yield more efficient outcomes at lower doses.

5. REFERENCES

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Table 1. The effects of Harpin and AVG treatments on fruit quality of 0900 Ziraat sweet cherry

Treatments (mgL^{-1})	Fruit size (mm)	Firmness (N)	Skin color	Flesh color	TA (%)	SSC (%)	SRF (N)
Control	25.0 a	0.40 a	3.8 bc	1.0 a	0.71 a	16.9 a	2.52 a
AVG250	24.7 ab	0.40 a	3.9 abc	1.3 a	0.76 a	16.1 ab	2.31 a
AVG500	24.8 a	0.36 ab	3.7 dc	1.2 a	0.60 a	17.0 a	2.04 a
Harpin125	22.1 d	0.32 b	4.3 a	1.2 a	0.59 a	15.4 bc	0.89 b
Harpin250	22.2 d	0.31 b	4.3 a	1.3 a	0.61 a	15.0 c	0.82 b
AVG250Harpin125	23.9 bc	0.33 b	3.7 dc	1.3 a	0.75 a	16.8 a	2.08 a
AVG250Harpin250	23.8 c	0.37 ab	3.6 dc	1.1 a	0.70 a	17.0 a	2.09 a
AVG500Harpin125	23.8 c	0.36 ab	3.8 bc	1.3 a	0.69 a	16.8 a	2.19 a
AVG500Harpin250	23.2 c	0.37 ab	3.5 dc	1.1 a	0.73 a	16.2 ab	2.26 a

The means showed same latter in same column are not significantly different at P=0.05

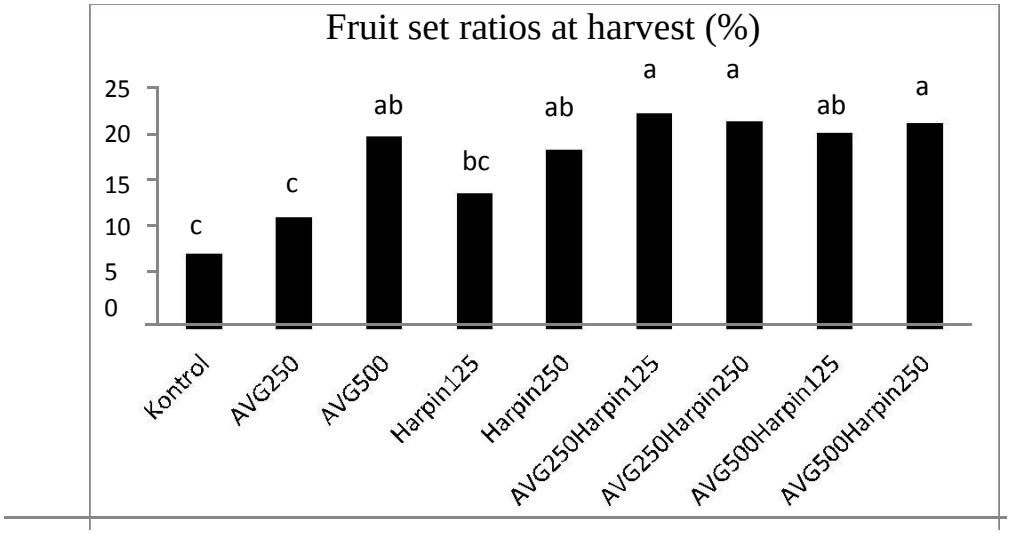

Figure 1. The effect of AVG and Harpin treatments on fruit set of 0900 Ziraat sweet cherry
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