

# Induction of Lateral Branching in Sweet Cherry (*Prunus avium* L. cvs. “Siah Mashhad” & “Dovomras”) Trees in Nursery

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## Abstract

This study was carried out in two independent experiments on one year old sweet cherry (*Prunus avium* L. cvs. “Siah Mashhad” and “Dovomras”) nursery trees with the main purpose of improving lateral shoot formation and increasing the quality of trees. In the first experiment, heading treatments (0, 40, 60 and 80 cm above ground) and in the second experiment, Arbolin treatments (0, 5, 15, 25 mL·L<sup>-1</sup>) was investigated. Trees were treated with foliar sprays of Arbolin in 2 times at 7-days intervals in mid-June. At the end of the growing season, the tree quality was measured on the basis of their diameter and height of trees, number, length and angles of lateral shoots. A factorial experiment was laid out in a completely randomized block design with 3 replications where each plot contained 10 trees. Results showed that all of the treatments increased the number of laterals in comparison with the control. The cultivars had different response to the treatments. Heading in 60 cm was the best treatment for improving total number of lateral shoots. The result of second experiment showed that there were significant differences between cultivars and Arbolin treatments. The number of lateral shoots enhanced with application of higher concentrations and repeated Arbolin treatments in both cultivars. Arbolin treatments had more significant effect on the number and length of lateral shoots than heading treatments.

**Keywords:** Arbolin, heading, lateral shoot, stem diameter, tree quality

## 1. Introduction

In Iran, most of young sweet cherry trees do not have any lateral shoots like a whip. One of the main purposes of fruit tree nurserymen is improving lateral shoot formation and increasing the quality of sweet cherry trees. For this purpose, the first step is to obtain good trees that are well branched (feathered). A number of lateral branches provide the opportunity to obtain good tree architecture in the future. Moreover, the height, location and the wide angle of laterals provide earlier and higher yields (Hrotko et al., 1996a). Nursery material of high quality is the basic condition of intensive fruit growing (Kaplan & Baryla, 2006). If not properly managed, scaffold branches and leaders of young sweet cherry trees produce hardly any laterals (Jacyna & Puchala, 2004). Formation of lateral shoots differs among sweet cherry cultivars and is determined by the apical dominance of the cultivar. Most of the sweet cherry cultivars exhibit strong apical dominance, in young trees (Elfving & Visser, 2007).

Pruning (tipping) can interrupt the apical dominance mechanism and encourage buds that might remain quiescent (Elfving & Visser, 2007). Traditionally, the stimulation of lateral branches has been done in sweet cherries by heading candidate shoots. Heading is simple to explain to workers and inexpensive to perform (Hoying et al., 2001). Many researchers pointed out that heading alone had little effect on branching with either cultivar (Poniedzialek & Porębski, 1995). Although removal of the shoot tip by hand caused production of branches, but the number of laterals was insufficient to form proper tree crown. Moreover, these feathers had too narrow angles (Gastol & Poinziak, 2003). Pruning increased cytokinin-, auxin-, and gibberellin-like activity by about 90, 60 and 190%, respectively (Mika, 1986). It is known, however, that tipping may cause an increase in the activity of hormones responsible for shoot growth, thus increasing their number and length (Mika, 1986). Traditional techniques to promote branching not always give satisfactory results, so application of bioregulators may be necessary (Csiszar & Buban, 2004).

Branching also may be stimulated by a chemical treatment. Certain plant bioregulators are able to break the dormant state of summer buds (Elfving, 1985). Cytokinins such as benzyladenine (BA), alone or in combination with gibberellins, have been used to overcome apical dominance and stimulate the development of lateral shoots, with positive results in many countries (Jaumien et al., 2002). They are successfully applied for different fruit crops (Magyar & Hrotko, 2005; Neri et al., 2004). Preliminary results have confirmed that Arbolin 036 SL promotes branching in nursery apple trees. Arbolin is highly effective in producing well branched trees (Jaumien et al., 2002). Detailed study by Jacyna and Puchała (2004) demonstrated small movement of induction zone when BA + GA<sub>4+7</sub> or BA + GA<sub>3</sub> were applied to sweet cherry shoots. The BA treatments significantly increased the crotch angle of lateral shoots compared with control (Keever et al., 1993; Caglar & Ilgin, 2009). Multiple application of GA<sub>4+7</sub> beginning 18 day after BA sprays induced the longest branches, most total branch growth and greatest branch crotch angles than applications involving a single GA<sub>4+7</sub> + BA (Volz et al., 1994).

The main purpose of this study was to increase the number of lateral shoots and also to improve the feathering of young sweet cherry trees in nursery.

## 2. Materials and Methods

This study was conducted in two independent experiments on one-year-old sweet cherry (*Prunus avium* L. cvs. “Siah Mashhad” and “Dovomras”) trees budded on the Mahaleb seedling rootstock in a commercial sweet cherry nursery. The nursery was located at Golmakan Horticultural Research Station (59° 17' N; 36° 32' E), north east of Iran/Mashhad, with an average altitude of about 1176 m. In 2011, the mean temperature for growing season was 13.4°C and total seasonal precipitation was 239.7 mm. The nursery soil was sandy loam with low organic matter. Drip irrigation was applied in the nursery. The trees were planted at a spacing of 100 × 10 cm (100,000 trees ha<sup>-1</sup>) and budded (T-budding technique) 10 cm above the ground level.

### 2.1 Experimental 1. Heading Treatments

In the late of spring of the 1st year of planting, trees of “Siah Mashhad” and “Dovomras” cultivars were pruned at the height of 40, 60 and 80 cm above the soil level. Trees did not have any lateral branch, when treatments were applied.

### 2.2 Experimental 2. Arbolin Treatments

The Arbolin concentrations used were 0, 5, 15 and 25 mL·L<sup>-1</sup>. The treatments were repeated at 7-days interval at two times (15 and 22 June). Untreated (Control) trees were sprayed with only water at each spraying. Trees do not have any lateral branch when treatments applied. The upper 20 cm of actively growing scion shoots with leaves were sprayed with atomizer-type hand sprayers (Cody et al., 1985).

### 2.3 Data Collection

At the end of the growing season, the quality of the two-year-old planting material was measured on the basis of tree height (from the graft union), tree diameter (10 cm above the graft union), number, length and angles of lateral shoots. A factorial experiment was laid out in completely randomized block design with 3 replications where each replication contained 10 trees. All data were subjected to analysis of variance and Duncan's multiple range test were used to compare the treatment means. Differences at  $p < 0.05$  were considered to be significant.

## 3. Results and Discussion

### 3.1 Experimental 1. Heading Treatments

There were significant differences between cultivars and heading treatments. “Dovomras” had better response to heading treatments than “Siah Mashhad” cultivar (Table 1). The total number of lateral shoots increased with heading in comparison with the control. All the treatments effectively enhanced the feathering of young sweet cherry trees. Heading in 60 cm, was the best treatment for improving the total number of lateral shoots.

The number of long lateral shoots (> 10 cm) and short lateral shoots (< 10 cm) were also affected with heading treatments. There were not significant differences between 60 to 80 cm and 40 to 60 cm in “Dovomras” and “Siah Mashhad” cultivars, respectively (Table 1). Heading in 40 cm was the best treatment for inducing the short lateral shoots (< 10 cm) in “Siah Mashhad” cultivar (Table 1). The length of long lateral shoots (> 10 m) and short lateral shoots (< 10 cm) increased with heading treatments in comparison with control. With increasing of heading height improved the long laterals, so that, heading at 80 cm induced the most longest laterals in comparison with other heading treatments. The most length of short laterals produced at the height of 40 and 60 cm in “Siah Mashhad” and “Dovomras” cultivar, respectively (Table 1).

Table 1. The effect of heading treatments on the number of laterals

Heading (cm)	Number of laterals per tree			Length of lateral shoots	
	Total	>10 cm	<10 cm	>10 cm	<10 cm
“Siah Mashhad”					
Control	1.6cd*	1.5de	0.1bc	37.3d	1.2e
40	3.5ab	2.9b	0.6a	39.3c	4.0a
60	3.1bc	2.8b	0.3b	39.8bc	3.2bc
80	2.3c	2.2d	0.1bc	46.5a	2.0d
“Dovomras”					
Control	0.7d	0.7e	0.0c	35.7f	1.0e
40	2.6bc	2.4cd	0.2bc	36.5ef	2.8c
60	3.7a	3.5a	0.2bc	37.3de	3.8b
80	3.7a	3.5a	0.1bc	40.6b	2.0d

\*Means with similar letter in each column are not significantly different at 5% level.

Heights and stem diameters of treated trees were lower than control trees (Table 2). For both cultivars, heading at 80 cm improved the height and stem diameter of trees. Heading in 60 cm increased the height of treated trees more than 40 cm. The laterals angles have significant differences with control. Heading at 60 cm was induced the most laterals angle in comparison with other headings and also control (Table 2).

Table 2. The effect of heading treatments on the growth of tree leader

Heading (cm)	Height (cm)	Stem diameter (mm)	Angel of lateral croches (°)
“Siah Mashhad”			
Control	183.9a*	17.5a	30.0f
40	112.6c	14.1ab	32.3o
60	120.6c	13.5b	48.2a
80	144.5b	14.5ab	35.0c
“Dovomras”			
Control	161.2ab	15.7ab	28.0g
40	73.9d	10.9c	31.0e
60	115.5c	13.1bc	41.0b
80	150.2b	15.6ab	30.0f

\*Means with similar letter in each column are not significantly different at 5% level.

### 3.2 Experimental 2. Arbolin Treatments

Arbolin treatments significantly increased the total number of lateral shoots per tree compared with the untreated trees (control). In both cultivar, the best response for inducing total lateral shoots was when higher concentrations of Arbolin applied but 15 mL·L<sup>-1</sup> was better than 25 mL·L<sup>-1</sup> in “Dovomras” cultivar for lateral shoot formation (Figure 1). “Siah Mashhad” had better response to Arbolin treatments than “Dovomras” cultivar. Repeated Arbolin treatments produced more total lateral shoots than a single treatment (Figure 2). There was not any significant difference between 15 and 25 mL·L<sup>-1</sup> with two sprays in “Dovomras” cultivar.

The number of lateral shoots >10 and < 10 cm also were affected with Arbolin treatments. In most of Arbolin treated trees, the number of laterals > 10 cm were significantly greater than control. The most number of lateral shoots > 10 cm observed in Arbolin 15 × 1 and 15 × 2 in “Dovomras” and “Siah Mashhad” cultivars, respectively.

The number of laterals < 10 cm in length increased with repeated Arbolin sprays (Table 3). The length of long lateral shoots (> 10 m) and short lateral shoots (< 10 cm) also increased with Arbolin treatments in comparison with control. The most length of long laterals (> 10 cm) were observed in the 15 and 5 with 1 sprays in Siah Mashhad and Dovomras cultivar, respectively. For both cultivars, the best treatment for inducing length and number of lateral shoots < 10 cm was observed in Arbolin 25 × 2 sprays (Table 3).

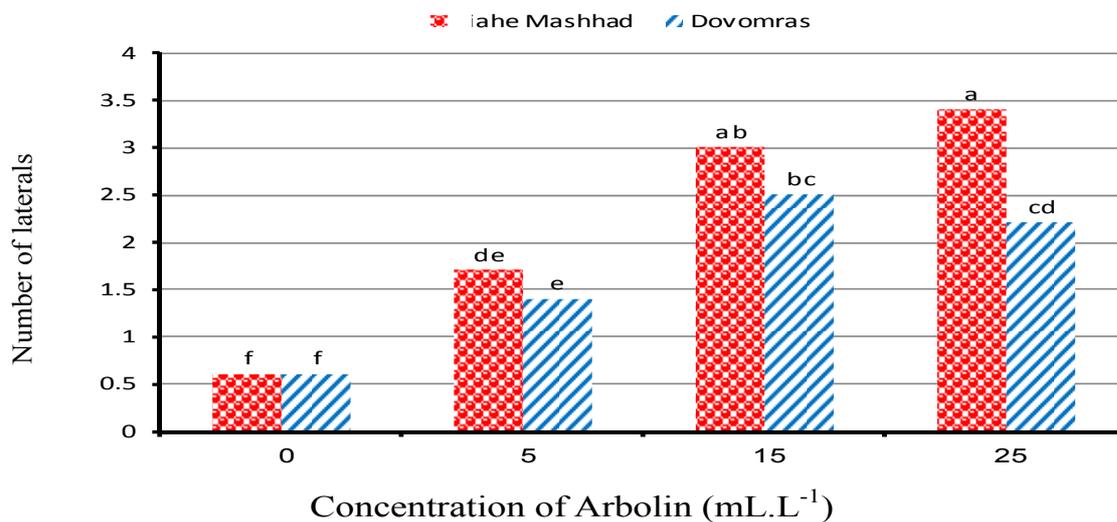


Figure 1. Effect of cultivar and Arbolin concentrations on the total number of lateral shoots

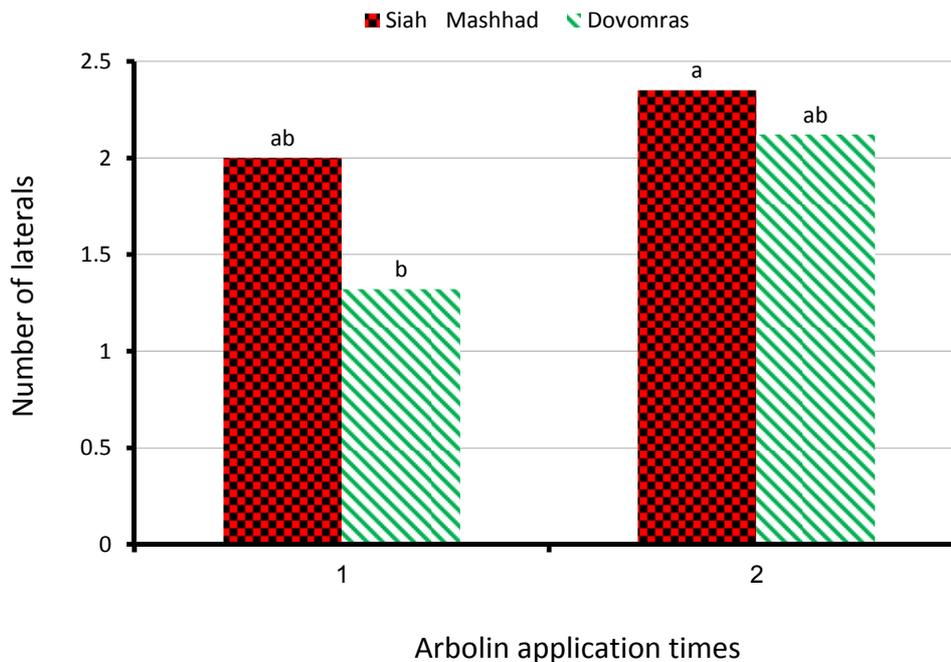


Figure 2. Effect of cultivar and Arbolin application times on the total number of lateral shoots

Height of Arbolin treatments were slightly more than control trees. The strongest influence for height and diameter was observed when Arbolin was applied at the dose of 25 mL.L<sup>-1</sup> twice and 5 mL.L<sup>-1</sup> in “Siah Mashhad” and “Dovomras” respectively. “Siah Mashhad” genetically was higher than “Dovomras” cultivar and with application of Arbolin treatments also was the same. The angles of laterals shoots in the Arbolin treatments were wider (between 40° and 59°) than control (28°) (Table 4).

Table 3. The effect of Arbolin treatments on the number of lateral shoots

Treatments	Number of laterals per tree			Length of lateral shoots	
	Total	>10	<10	>10 cm	<10 cm
“Siah Mashhad”					
Control	1.6 de**	1.5 def	0.1 f	37.1g	1.2l
AR5×1*	1.7 de	1.3 def	0.4 def	38.9de	1.3k
AR5×2	1.6 de	0.8 fg	0.8 bcd	40.2c	1.5j
AR15×1	3.3 b	3.2 a	0.1 ef	51.2a	2.9d
AR15×2	2.7 bc	1.4 def	1.3 b	38.2ef	1.9h
AR25×1	2.6 bcd	1.7 bcde	0.9 bcd	37.8fg	1.3k
AR25×2	4.3 a	2.5 b	1.8 a	37.3fg	4.1a
“Dovomras”					
Control	0.7 g	0.7 g	0.0 f	35.5h	1.0m
AR5×1	1.4 efg	1.3 def	0.1 f	44.7b	2.6e
AR5×2	1.5 ef	1.4 def	0.1 f	39.9c	1.6i
AR15×1	1.9 cde	1.7 bcde	0.2 cd	37.6fg	2.1g
AR15×2	3.1 b	2.5 b	0.6 cde	39.3cd	3.1l
AR25×1	1.2 efg	0.9 efg	0.3 ef	39.9c	2.2f
AR25×2	3.2 b	2.1 bcd	1.1 bc	35.7h	3.2b

\*Repeated sprays (1 and 2) were applied at 7-days interval, starting 15 June 2011.

\*\*Means with similar letter in each column are not significantly different at 5% level.

Table 4. The effect of Arbolin treatments on the growth of tree leader

Treatments	Height (cm)	Diameter (mm)	Angel of lateral croches (°)
“Siah Mashhad”			
Control	183.9 ab**	17.5 a	30.0 k
AR5×1*	198.9 a	15.8 c	52.2 e
AR5×2	161.3 bcde	13.2 i	59.2 a
AR15×1	186 ab	14.9 ef	40.0 j
AR15×2	164.8 bcd	14.4 g	55.3 c
AR25×1	166.9 bc	13.7 h	49.0 g
AR25×2	196.2 a	16.6 b	53.0 d
“Dovomras”			
Control	161.2 bcde	15.7 c	28.0 i
AR5×1	172.0 b	16.4 b	50.0 f
AR5×2	124.2 f	15.2 d	57.2 b
AR15×1	132.8 def	12.5 j	40.0 j
AR15×2	147.1 bcdef	15.2 d	41.3 i
AR25×1	131.5 ef	11.6 k	46.0 h
AR25×2	139.4 cdef	14.6 fg	49.3 g

\*Repeated sprays (1 and 2) were applied at 7-day interval, starting 15 June 2011.

\*\*Means with similar letter in each column are not significantly different at 5% level.

#### 4. Discussion

There were significant differences between cultivars and heading treatments. “Dovomras” had better response to heading treatments than “Siah Mashhad” cultivar. The total number of lateral shoots increased with heading in comparison with the control. All the treatments effectively enhanced the feathering of young sweet cherry trees. Heading in 60 cm, was the best treatment for improving the total number of lateral shoots.

The number of long lateral shoots ( $> 10$  cm) and short lateral shoots ( $< 10$  cm) were also affected with heading treatments. There were not significant differences between 60 to 80 cm and 40 to 60 cm in “Dovomras” and “Siah Mashhad” cultivars, respectively. Heading in high heights (60 and 80 cm) could induce the number of long laterals ( $> 10$  cm) more than 40 cm in “Dovomras” cultivar. Heading in 40 cm was the best treatment for inducing the short lateral shoots ( $< 10$  cm) in “Siah Mashhad” cultivar. Similar data were presented by Bielicki and Czynczyk (2004) that reported for high quality of planting material, trees should be pruned at the height of 65 cm. The length of long lateral shoots ( $> 10$  m) and short lateral shoots ( $< 10$  cm) increased with heading treatments in comparison with control. With increasing of heading height improved the long laterals, so that, heading at 80 cm induced the most long laterals in comparison with other heading treatments. The most length of short laterals produced at the height of 40 and 60 cm in “Siah Mashhad” and “Dovomras” cultivar, respectively. This result is confirmed by Clements et al. (2010) that found heading increase the total lateral growth.

Heights and stem diameters of treated trees were lower than control trees. Foreshy (1986) reported that the plenty of regrowth is in relation with intensity of pruning and the most effect of heading is the reduction of total vegetative growth and it is agreed with our result. For both cultivars, heading at 80 cm improved the height and stem diameter of trees. Similar data were presented by Gudarowska et al. (2006) that reported pruning at the height of 80 cm improved the height of “Ligol” apple trees and also pruning at 40 and 60 cm positively affected the feathering of treated trees. Heading in 60 cm increased the height of treated trees more than 40 cm and it is confirmed by Gudarowska (2002) that reported pruning at the height of 60 cm improved the feathering of planting material, without reduction of tree height, in comparison with pruning at the height of 40 cm.

Arbolin treatments significantly increased the total number of lateral shoots per tree compared with the untreated trees (control). In both cultivar, the best response for inducing total lateral shoots was when higher concentrations of Arbolin applied but  $15 \text{ mL}\cdot\text{L}^{-1}$  was better than  $25 \text{ mL}\cdot\text{L}^{-1}$  in “Dovomras” cultivar for lateral shoot formation and it is agreement with Jacyna and Puchala (2004) that found application of Promalin and Arbolin, significantly increased the number of shoots and the branching effect was correlated with an increase of rate of active ingredients. “Siah Mashhad” had better response to Arbolin treatments than “Dovomras” cultivar. Repeated Arbolin treatments produced more total lateral shoots than a single treatment. Regular application of plant growth hormones could increase the number of laterals that is reported for cherries (Magyar & Hrotko, 2005) and it is agreed with our result. There was not any significant difference between 15 and  $25 \text{ mL}\cdot\text{L}^{-1}$  with two sprays in “Dovomras” cultivar.

The number and length of lateral shoots  $> 10$  and  $< 10$  cm also were affected with Arbolin treatments. In all of Arbolin treated trees, the number of laterals  $> 10$  cm were significantly greater than control. The most number of lateral shoots  $> 10$  cm observed in Arbolin  $15 \times 1$  and  $15 \times 2$  in “Dovomras” and “Siah Mashhad” cultivars, respectively. The most length of long laterals ( $> 10$  cm) were observed in the 15 and 5 with 1 sprays in “Siah Mashhad” and “Dovomras” cultivar, respectively.

This result is agreement with Kviklys (2006) that reported the average length of sylleptic shoots was increased in most cases when plant growth regulator Arbolin was applied and also with Kopytowski et al. (2006) that found the highest length of lateral shoots over 20 cm was observed of cultivar “Elise” in the variant where Arbolin 036 SL was applied at the dose of  $15 \text{ mL}\cdot\text{L}^{-1}$  of water. For both cultivars, the best treatment for inducing lateral shoots  $< 10$  cm was observed in Arbolin  $25 \times 2$  sprays. The number of laterals  $< 10$  cm in length increased with repeated Arbolin sprays. Our results showed that the best shoots with high quality were produced in the height of 40-60 cm from graft union at Arbolin treatment with concentration of  $25 \text{ mL}\cdot\text{L}^{-1}$ . our results also confirmed by Gudarowska et al. (2006) and Bielicki and Czynczyk (2004).

Height of Arbolin treatments were slightly more than control trees. The strongest influence for height and diameter was observed when Arbolin was applied at the dose of  $25 \text{ mL}\cdot\text{L}^{-1}$  twice and  $5 \text{ mL}\cdot\text{L}^{-1}$  in “Siah Mashhad” and “Dovomras” respectively. “Siah Mashhad” genetically was higher than “Dovomras” cultivar and with application of Arbolin treatments also was the same. Kopytowski et al. (2006) reported that the highest trees were obtained in combinations where Arbolin 036 SL was applied at the dose of  $30 \text{ mL}\cdot\text{L}^{-1}$  of water and it is agreement with our result.

## 5. Conclusion

Based on results of these experiments, it is proved that heading and Arbolin application improves feathering and length of lateral shoots on young sweet cherry trees, but Arbolin applications was more effective than heading treatments. The number of lateral shoots enhanced with application of higher concentrations and repeated Arbolin treatments in both cultivars. Height of Arbolin treatments were slightly more than control trees. Angles of laterals with application of Arbolin treatments was wider than heading treatments. To develop the best practical method for nurseries, continued to more experiments should be carried out with more cultivars and study treatments influence on blooming, fruit setting and precocity.

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