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*Full Length Research Paper*

# The effects of heading and benzyladenine applications on branching of sweet cherry (*Prunus avium* L. cvs. 'Siah Mashhad' and 'Dovomras') trees in nursery

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**This experiment was carried out to study the effects of mechanical and chemical treatments for developing the lateral shoot and increasing the quality of one year old sweet cherry (Prunus avium L. 'Siah Mashhad' and 'Dovomras' cvs) trees in nursery. In the first experiment, heading treatments (0, 40, 60 and 80 cm above ground) and in the second experiment, benzyladenine (BA) treatments (0, 200, 400, 600 mgL$^{-1}$) was investigated. BA treatments were sprayed in mid-June when growth scion shoot were 60-65 cm above the bud union in three times at 7-day intervals. At the end of the growing season, the tree quality were measured on the basis of their diameter and height of trees, number and length 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 lateral shoots in comparison with the control. Heading in 60 cm was the best treatment for improving total number of lateral shoots. 'Dovomras' had better response to heading treatments than 'Siah Mashhad' cultivar. The result of second experiment showed that there were significant differences between cultivars and BA treatments. 'Siah Mashhad' had better response to BA than the 'Dovomras' cultivar. BA treatments had more significant effect on the number and length of lateral shoots than heading treatments. Repeated BA treatments induced lateral shoots more than a single treatment.**

**Key words:** 'Dovomras', feathering, lateral shoot, 'Siah Mashhad', tree quality.

## INTRODUCTION

In Iran, most of young sweet cherry trees do not have any whip-like lateral shoots. One of the main purposes of fruit tree nurserymen is improving lateral shoot formation and increasing the quality of sweet cherry trees.

Growers require well-branched maiden trees for planting intensive orchards as feathered trees with wide angled secondary laterals provide earlier and higher yields. Advanced training systems for sweet cherry trees are based on such planting material, thus improving the lateral shoot formation in nurseries is going to be more and more important (Zahn, 1996). If not properly managed, scaffold branches and leaders of young sweet cherry trees produce hardly any lateral shoots (Jacyna and 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, particularly in young trees (Jacyna and Puchala, 2004; Elfving and Visser, 2007). Pruning (tipping) can interrupt the apical dominance mechanism and encourage buds that might remain quiescent (Elfving and 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 (Poniedziałek and Porębski, 1995).

Pruning increased cytokinin-, auxin-, and gibberellin-like activity by about 90, 60 and 190%, respectively. It is known, however, that tipping may cause an increase in the activity of hormones responsible for shoot growth,

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thus increasing their number and length (Mika, 1986).

Branching also may be stimulated by a chemical treatment. Certain plant bioregulators are able to break the dormant state of summer buds. It seems, however, that by combining cultural and chemical methods, a more pronounced branching effect in young sweet cherry trees might be accomplished (Neri et al., 2004).

BA is one of these bioregulators used as a branching agent in nurseries and in young orchards (Looney, 1996; Hrotko et al., 1996a, b). Benzyladenine based (BA) compounds appear to be the most efficient in inducing branching (Elfving, 1985).

Application of the cytokinin 6-benzyladenine (BA) with or without gibberellic acid isomers $GA_{4+7}$ also improves feather formation in sweet cherry trees in the nursery (Elfving and Visser, 2006). However, 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).

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.

## 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. 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 a low organic matter. The drip irrigated was applied in the nursery. The trees were planted at a spacing of 100 × 10 cm (100.000 trees $ha^{-1}$) and budded (T-budding technique) 10 cm above the ground level.

### Experiment 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.

### Experiment 2: BA treatments

The BA concentrations used were 0, 200, 400 and 600 $mgL^{-1}$. The treatments were repeated at 7-day interval three times (15, 22 and 29 June). Untreated (Control) trees were sprayed with only water at each spraying. Trees do not have any lateral branch when treatments applied. BA was applied to the nursery trees in distilled water with the addition of Tween 20 as a non-ionic surfactant (Hrotko et al., 1996). The upper 20 cm of actively growing scion shoots with leaves were sprayed with atomizer-type hand sprayers (Cody et al., 1985). At the end of the growing season, the quality of the two-year- oldplanting material was measured on the basis of their diameter (10 cm above the graft zone), and height (from the graft union) of trees, number and length 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.

## RESULTS

### Experiment 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 no significant differences between 60 to 80 cm and 40 to 60 cm in 'Dovomras' and 'Siah Mashhad' cultivars, respectively (Table 1). Heading in high heights (60 and 80 cm) could induce the number of long laterals (>10 cm) more than 40 cm in 'Dovomras' cultivar (Table 1).

Heading in 40 cm was the best treatment for inducing the short lateral shoots (<10 cm) in 'Siah Mashhad' cultivar but there were no differences between heading treatments in 'Dovomras' cultivar (Table 1).

Height and stem diameter of treated trees were lower than control trees. There were no significant differences between 40 to 60 cm and 40 to 80 cm in the height and stem diameter, respectively in 'Siah Mashhad' cultivar (Table 2). Heading in 60 cm increased the height of treated trees more than 40 cm. For both cultivars, heading in 80 cm improved the height and stem diameter of trees (Table 2).

### Experiment 2: BA treatments

Benzyladenine treatments significantly increased the total number of lateral shoots compared with the untreated trees (control). The total number of lateral shoots improved with application, the higher concentrations of BA, so that, 600 $mgL^{-1}$ of BA was the best treatment for lateral shoot formation (Figure 1). 'Siah Mashhad' had better response to BA treatments than 'Dovomras' cultivar (Figure 2). Repeated BA treatments produced more total lateral shoots than a single treatment, although the difference was not statistically significant in 'Dovomras' cultivar (Figure 2). The number of long laterals (>10 cm) and short laterals (<10 cm) were also affected with BA treatments. In all of BA treated trees, the

**Table 1**. The effect of heading treatments on the number of lateral shoots

| | Number of laterals per tree | | |
|---|---|---|---|
| **Heading (cm)** | **Total** | **>10 cm** | **<10 cm** |
| **'Siah Mashhad'** | | | |
| Control | 1.6$^{cd**}$ | 1.5$^{de}$ | 0.1$^{bc}$ |
| 40 | 3.5$^{ab}$ | 2.9$^{b}$ | 0.6$^{a}$ |
| 60 | 3.1$^{bc}$ | 2.8$^{b}$ | 0.3$^{b}$ |
| 80 | 2.3$^{c}$ | 2.2$^{d}$ | 0.1$^{bc}$ |
| **'Dovomras'** | | | |
| Control | 0.7$^{d}$ | 0.7$^{e}$ | 0.0$^{c}$ |
| 40 | 2.6$^{bc}$ | 2.4$^{cd}$ | 0.2$^{bc}$ |
| 60 | 3.7$^{a}$ | 3.5$^{a}$ | 0.2$^{bc}$ |
| 80 | 3.7$^{a}$ | 3.5$^{a}$ | 0.1$^{bc}$ |

**Means with similar letter in each column are not significantly different at 5% level by Duncan's multiple range test.

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

| Heading (cm) | Height (cm) | Stem diameter (mm) |
|---|---|---|
| **'Siah Mashhad'** | | |
| Control | 183.9$^{a**}$ | 17.5$^{a}$ |
| 40 | 112.6$^{c}$ | 14.1$^{ab}$ |
| 60 | 120.6$^{c}$ | 13.5$^{b}$ |
| 80 | 144.5$^{b}$ | 14.5$^{ab}$ |
| **'Dovomras'** | | |
| Control | 161.2$^{ab}$ | 15.7$^{ab}$ |
| 40 | 73.9$^{d}$ | 10.9$^{c}$ |
| 60 | 115.5$^{c}$ | 13.1$^{bc}$ |
| 80 | 150.2$^{b}$ | 15.6$^{ab}$ |

**Means with similar letter in each column are not significantly different at 5% level by Duncan's multiple range test.

number of laterals >10 cm were significantly greater than control (Table 3). The most number of lateral shoots >10 cm was observed in BA600×2 and BA600×3 in 'Dovomras' and 'Siah Mashhad' cultivars, respectively (Table 3). The number of lateral shoots <10 cm increased with the application of the BA treatments compared to control.

For both cultivars, the best treatment for inducing lateral shoots <10 cm were observed in BA 600×3 sprays (Table 3). Heights and stem diameters of treated trees decreased slightly in comparison with control trees (Table 4).

## DISCUSSION

'Dovomras' had better response to heading treatments than 'Siah Mashhad' cultivar. 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. Heading in high heights (60 and 80 cm) could induce the number of long laterals (>10 cm) more than 40 cm in 'Dovomras' cultivar.

It is confirmed by Bielicki and Czynczyk (2004) that reported for high quality of planting material, trees should be pruned at the height of 65 cm. Gudarowska et al. (2006) also reported that pruning at 40 and 60 cm positively affected the feathering of treated trees. Heights and stem diameters of treated trees were lower than control trees. In both cultivars, heading in 60 cm increased the height of treated trees more than 40 cm. There were no significant differences between 40 to 60 cm and 40 to 80 cm in the height and stem diameter, respectively, in 'Siah Mashhad' cultivar (Table 2). It is in agreement with Foreshy (1986) who reported that the plenty of regrowth is in relation with intensity of pruning,

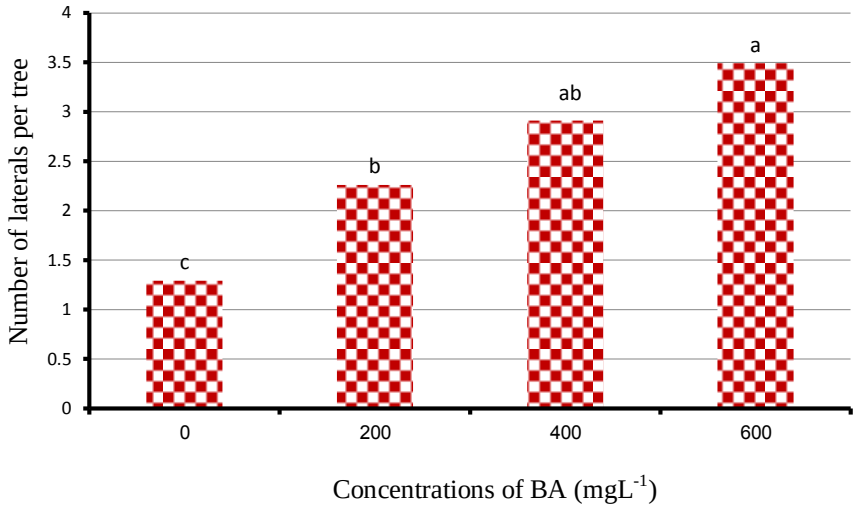


**Figure 1.** Effect of BA concentrations on the total number of lateral shoots.

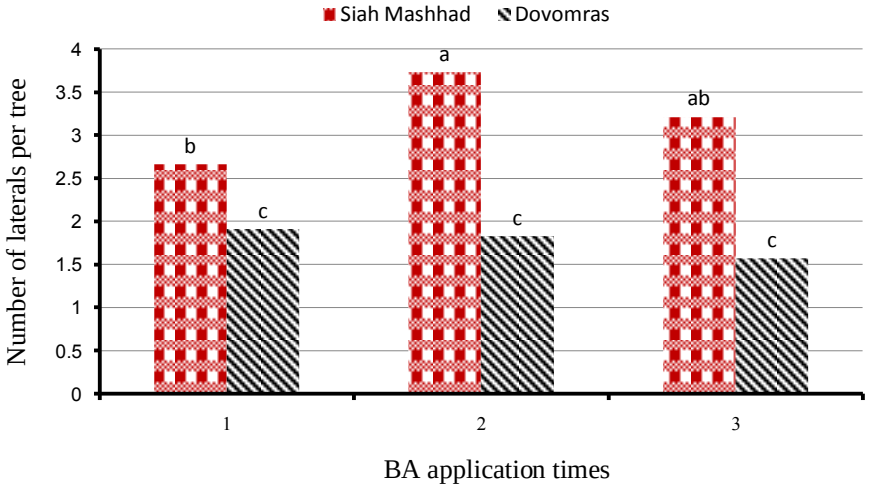


**Figure 2.** Effect of cultivar and BA application times on the total number of lateral shoots.

and the most effect of heading on trees is the reduction of total vegetative growth. For both cultivars, heading in 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. Benzyladenine treatments significantly increased the total number of lateral shoots compared with the untreated trees. The total number of lateral shoots improved with application higher concentrations of BA, so that, 600 $mgL^{-1}$ of BA was the best treatment for lateral shoot formation. Our results were confirmed by Taemyung et al. (2001) who reported that BA treatments were more effective on lateral shoot formation in 'Tsugaru' apple trees in nursery. 'Siah Mashhad' had better response to BA treatments than 'Dovomras' cultivar. Magyar and Hrotko (2005) reported that for such cultivars, more application of plant growth regulators might be needed to increase the percentage of branched trees, and this was confirmed by our result.

Repeated BA treatments produced more total lateral shoots than a single treatment although the difference was not statistically significant in 'Dovomras' cultivar. Regular application of plant growth hormones could increase the number of lateral shoots, which is reported for apples (Buban, 2000) and cherries (Magyar and Hrotko, 2005). For both cultivars, the best treatments for inducing short laterals (<10 cm) were observed in 600×3 sprays. Application of higher concentrations of BA, benefits to short laterals formation (Magyar and Hrotko, 2002) and is in agreement with our results. Height and

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

| Treatments | Number of laterals per tree | | |
|---|---|---|---|
| | Total | >10 cm | <10 cm |
| **'Siah Mashhad'** | | | |
| Control | 1.6$^{de**}$ | 1.5$^{cde}$ | 0.1$^{e}$ |
| BA200×1† | 2.6$^{cde}$ | 2.4$^{bcd}$ | 0.2$^{de}$ |
| BA200×2 | 3.7$^{bc}$ | 1.9$^{cde}$ | 1.8$^{ab}$ |
| BA200×3 | 3.0$^{cde}$ | 2.6$^{bc}$ | 0.4$^{de}$ |
| BA400×1 | 3.4 $^{bc}$ | 2.2$^{cde}$ | 1.2$^{bcd}$ |
| BA400×2 | 4.0$^{bc}$ | 2.4$^{cd}$ | 1.6$^{abc}$ |
| BA400×3 | 3.8$^{bc}$ | 2.6$^{bc}$ | 1.2$^{bcd}$ |
| BA600×1 | 2.6$^{cde}$ | 1.8$^{cde}$ | 0.8$^{bcde}$ |
| BA600×2 | 5.7$^{ab}$ | 3.9$^{ab}$ | 1.8$^{ab}$ |
| BA600×3 | 6.4$^{a}$ | 4.2$^{a}$ | 2.2$^{a}$ |
| **'Dovomras'** | | | |
| Control | 0.7$^{e}$ | 0.7$^{e}$ | 0.0$^{e}$ |
| BA200×1 | 1.7$^{cde}$ | 1.7$^{cde}$ | 0.0$^{e}$ |
| BA200×2 | 2.0$^{cde}$ | 2.0$^{cde}$ | 0.0$^{e}$ |
| BA200×3 | 0.9$^{de}$ | 0.9$^{de}$ | 0.0$^{e}$ |
| BA400×1 | 2.9$^{cde}$ | 2.4$^{bcd}$ | 0.5$^{cde}$ |
| BA400×2 | 1.8$^{cde}$ | 1.7$^{cde}$ | 0.1$^{de}$ |
| BA400×3 | 1.9$^{cde}$ | 1.3$^{cde}$ | 0.6$^{cde}$ |
| BA600×1 | 2.4$^{cde}$ | 2.0$^{cde}$ | 0.4$^{de}$ |
| BA600×2 | 3.3$^{bcd}$ | 2.9$^{abc}$ | 0.4$^{de}$ |
| BA600×3 | 3.0$^{cde}$ | 1.8$^{cde}$ | 1.2$^{abcd}$ |

†Repeated sprays (1, 2 and 3) were applied at 7- day interval, starting 15 June 2011.
**Means with similar letter in each column are not significantly different at 5% level by Duncan's multiple range test.

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

| Treatments | Height (cm) | Stem diameter (mm) |
|---|---|---|
| **'Siah Mashhad'** | | |
| Control | 183.9$^{a**}$ | 17.5$^{a}$ |
| BA200×1† | 155.7$^{bc}$ | 15.2$^{ab}$ |
| BA200×2 | 160.5$^{abc}$ | 13.7$^{b}$ |
| BA200×3 | 180.7$^{abc}$ | 16.5$^{ab}$ |
| BA400×1 | 159.2$^{abc}$ | 15.1$^{ab}$ |
| BA400×2 | 176.0$^{abc}$ | 14.7$^{ab}$ |
| BA400×3 | 180.5$^{abc}$ | 15.9$^{ab}$ |
| BA600×1 | 151.8$^{c}$ | 13.6$^{b}$ |
| BA600×2 | 183.3$^{ab}$ | 16.2$^{ab}$ |
| BA600×3 | 157.7$^{abc}$ | 16.1$^{ab}$ |
| **'Dovomras'** | | |
| Control | 161.2$^{abc}$ | 15.7$^{ab}$ |
| BA200×1 | 173.0$^{abc}$ | 15.9$^{ab}$ |
| BA200×2 | 180.0$^{abc}$ | 16.0$^{ab}$ |
| BA200×3 | 172.2$^{abc}$ | 15.3$^{ab}$ |
| BA400×1 | 172.2$^{abc}$ | 16.2$^{ab}$ |
| BA400×2 | 180.5$^{abc}$ | 16.0$^{ab}$ |

**Table 4.** Contd.

| | | |
|---|---|---|
| BA400×3 | 157.5$^{abc}$ | 16.0$^{ab}$ |
| BA600×1 | 183.8$^{ab}$ | 16.2$^{ab}$ |
| BA600×2 | 183.8$^{ab}$ | 16.5$^{ab}$ |
| BA600×3 | 183.8$^{ab}$ | 16.5$^{ab}$ |

†Repeated sprays (1, 2 and 3) were applied at 7- day interval, starting 15 June 2011. **Means with similar letter in each column are not significantly different at 5% level by Duncan's multiple range test.

stem diameters of treated trees decreased slightly in comparison with control trees. These results agree with Caglar and Ilgin (2009) who found that the heights and stem diameters of BA treated trees were slightly lower than control trees. Hrotkó et al. (1999) also found that the 'Germersdorfi FL45' sweet cherry trees treated with 6-BA were significantly smaller than the untreated control trees. The chemical treatments produced greater branch number than mechanical heading. Reduction in the tree size from chemical treatments were usually no greater, and sometimes less, than from mechanical heading (Cody et al., 1985; Gudarowska and Szewczuk, 2004) and it is agreement with our results.

## Conclusion

Based on results of these experiments, it is proved that heading and BA application improve the feathering of young sweet cherry in case of Siah Mashhad and Dovomras cvs in nursery, but BA applications was more effective than heading treatments. Heading in 60 cm, was the best treatment for improving the quality of treated trees. The number of lateral shoots enhanced with application of higher concentrations (600 $mgL^{-1}$) and repeated BA treatments in both cultivars. Height and stem diameter decreased in both treatments. To develop the best practical method for nurseries, more experiments should be carried out with more cultivars.

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