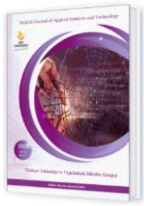
Türkiye Teknoloji ve Uygulamalı Bilimler Dergisi



ISSN: 2528-8652 e-ISSN: 2822-2660
Period Biannually Founded 2017 Publisher Siirt University
https://dergipark.org.tr/tr/pub/tubid

Siyah ve şeffaf malçın Sweet Heart kiraz (Prunus avium) çeşidinde yan dallanma, morfolojik ve pomolojik özellikler üzerine etkisi

Effects of Black and Clear Mulches Treatments on Lateral Branching, Morphological and Fruit Characteristics of *Prunus avium cv.* "Sweet Heart"

Murat ŞAHİN*
Siirt Üniversitesi, Ziraat Fakültesi, Bahçe Bitkileri Bölümü, Siirt, Türkiye
https://orcid.org/0000- 0002-5667-5483

Ahmet EŞİTKEN
Selçuk Üniversitesi, Ziraat Fakültesi, Bahçe Bitkileri Bölümü, Konya, Türkiye
https://orcid.org/0000- 0002-6140-7782

Lütfi PIRLAK
Selçuk Üniversitesi, Ziraat Fakültesi, Bahçe Bitkileri Bölümü, Konya, Türkiye
https://orcid.org/0000- 0003-3630-3591

Araştırma Makalesi

Geliş Tarihi

02/01/2019

Kabul Tarihi

22/09/2022

DOI

10.5281/zenodo.7236627

Özet

Bu çalışmada, perlan (GA_{4+7}+BA) uygulanmış Sweet heart kiraz çeşidinde malç uygulamalarının dallanma ve meyve özellikleri üzerine etkisi incelenmiştir. Çalışmada, Mazzard anacı üzerine aşılanmış Sweet Heart kiraz çeşidi kullanılmış ve aşılı fidanlar 3 tekerrürlü ve tekerrürde 8 bitki olacak şekilde dikilmiştir. Mart ayı içinde malç uygulamaları yapılmış ve aşı sürgünü uzunluğu 50 cm'yi aşınca Perlan uygulanmıştır. Kasım 2013'te morfolojik, Haziran 2015'te pomolojik ve Nisan 2016'da çiçek sayısı özellikleri alınmıştır. Çalışmada bitki boyu (BB), gövde çapı (GÇ), ilk dal yüksekliği (İDY), yan dal sayısı (YDS), yan dal uzunluğu (YDU), yan dal çapı (YDÇ), yan dal açısı (YDA), bitki başına meyve verimi (BBMV), bitki başına meyve sayısı (BBMS), meyve veren bitki oranı (MVBO), meyve çapı (MÇ) ve çiçek sayısı (ÇS) incelenmiştir. Siyah malç (SM) uygulaması çiçek sayısı dışındaki tüm parametrelerde en etkili uygulama olarak ortaya çıkmıştır. SM uygulaması ile 1.71 adet YDS, 48.5º YDA, 27.23 cm YDU, 6.73 mm YDÇ, 79.77 g BBMV, 11.80 adet BBMS, 23.38 mm MÇ ve 6/7 oranında MVBO sağlanmıştır. Bununla birlikte, en yüksek ÇS (83.67 adet) şeffaf malç (ŞM) uygulamasından elde edilmiştir. Elde edilen sonuçlara göre, SM uygulaması oluşturduğu iyi gelişmiş yan dallar sebebiyle üreticilerine tavsiye edilebilir. Ayrıca, ilk meyve yılında bitki başına en yüksek verim SM uygulamasından elde edilmişken, ikinci meyve yılında ŞM uygulaması en fazla sayıda çiçeği meydana getirmiştir.

Anahtar Kelimeler: Kiraz, siyah malç, şeffaf malç, silepsis, tepe tomurcuğu hâkimiyeti

*Coressponding Author: : muratsahin@siirt.edu.tr

Effects of Black and Clear Mulches Treatments on Lateral Branching, Morphological and Fruit Characteristics of *Prunus avium cv.* "Sweet Heart"

Research Article

Received

02/01/2019

Accepted

22/09/2022

DOI

10.5281/zenodo.7236627

Abstract

In this study, the effects of mulch treatments on branching and fruit characteristics of sweet cherry cv. Sweet Heart treated with perlan (GA_{4+7}+BA) were investigated. Sweet Heart seedlings grafted on "Mazzard rootstock". Grafted trees were planted as 3 replicates and 8 saplings per replicate. Mulch materials were applied at the end of March and perlan was applied when the average plant height reached 50 cm. The data were collected in November 2013 (tree and branch characteristics), June 2015 (fruit characteristics), and April 2016 (Number of flowers). Plant height, stem diameter, the height of the first branch, lateral branch numbers, lengths, diameters, and angles, yield per plant, number of fruits per plant, fruit-bearing tree rate, fruit diameter, and the number of flowers per plant were investigated. Statistically significant results were observed for all parameters evaluated. Black mulch (BM) treatment was found as the most effective on all traits except the number of flowers per plant. As a result of the BM treatment, lateral branches per plant (1.71), branch angle (48.50°), branch length (27.23 cm), and branch diameter (6.73 mm) values were obtained. Also, fruit weight per plant (79.77 g), number of fruits per plant (11.80), fruit diameter (23.38 mm), and fruit-bearing tree rate (6/7) were obtained in BM treatment. Nevertheless, the maximum number of flowers (83.67) per plant was observed on clear mulch (CM) treatment in the second year. Based on the observations, well-developed lateral branch formation caused by BM treatment may be useful for nursery tree producers. Also, BM-treated trees had the highest fruit yield per plant for the first fruit year, while CM provided the highest fruit yield in the second year.

Keywords: Cherry, black mulch, clear mulch, syllepsis, apical dominance.

1. Introduction

Cherry (*Prunus avium* L.) belongs to the *Prunus* genus of the *Prunoideae* subfamily of the *Rosaceae* family (1). The center of origin of cherries is between South Caucasia, the Caspian Sea, and North Eastern Anatolia (2,3), and spread from there to Central and Southern Europe, Caucasia, and North West Iran (4). Cherry is grown widely in the World, but 25 countries produce 90% of all cherries worldwide, while Turkey, the USA, Iran, Chile, Italy, Spain, Romania, and Greece are the top producers (5).

Fruit farming requires well-branched and broad-angled nursery trees to produce fruit at early ages (6,7,8). In the orchards established with this type of saplings, more flower buds are formed in the first years and well-branched saplings give higher quality fruits (9,10). Such fruit orchards give earlier and higher yields than orchards set up with unbranched trees (11).

Many fruit cultivars give little or no branches at the sapling stage because of the apical dominance. Apical dominance is the inhibition of axillary buds by apical meristem in most of the higher plants (12). The apical meristem causes apical dominance with; 1) Indirect effect of auxin transport from shoot apical meristem to root apical meristem by basipetal pathway (Obstruction of vascular connections formation by preventing the lateral buds from giving auxin to the polar transport flow, to increase the synthesis of strigolactone, which prevents the growth of buds by entering the lateral buds with acropetal pathway), 2) by preventing the cytokinins (which directly affects the development of lateral buds) from reaching the lateral buds (13,14,15,16,17,18).

The root activity and thus the root biomass can be increased by increasing the root zone temperature. As a result, the production of cytokinin in the roots can be increased. This increase in cytokinin production may cause an increase in lateral branch formation. Dun et al. (14) argue that the high auxin transport capacity of young tree trunks contributes to the weakness of apical dominance. Auxin causes apical dominance by filling the limited auxin transport capacity of the tree trunk. The dormant axillary buds, cannot provide auxin into polar transport flow, because of the auxin supply from the apical meristem (on the top part of the tree) to the roots. According to Ongaro and Leyser's (15) study on high auxin transport capacity mutants of *Arabidopsis thaliana*, apical meristem could not fill this capacity, and thus most of the lateral buds form new branches by sending auxin to polar flow. As described above, early and extra-root development can affect lateral branch formation by altering the auxin-cytokinin balance. In this study, the effect of black and clear mulch was evaluated on promoting root development in early developmental stages.

2. Materials and Methods

This study was carried out at the Research and Application Orchard of the Department of Horticulture, Faculty of Agriculture at Selçuk University in 2013. In this study, effects of black and clear mulch treatments on branching of sweet cherry cv. Sweet Heart grafted on Mazzard (*P. avium* L.) was investigated. Perlan (% 18.5 GA_{4+7}+ % 18.8 BA, Sumitomo) was treated for all treatments. With this aim, black and clear mulch (at the end of March) and 600 ppm perlan were treated on young cherry trees (50 cm in height). Perlan was sprayed onto the extended shoots of all plants two times at three days intervals with a hand pump.

Saplings grafted on Mazzard were planted in February. Tree spacing was 90 cm between rows and 30 cm in a row. Fertilization, irrigation, and pest and weed control have been regularly treated according to nursery protocols. The treatments are; control, black mulch, and clear (transparent) mulch. Trunk diameter (5 cm above the graft zone), plant height (from the ground), number of lateral branches longer than 10 cm, lateral branch lengths (from the tree trunk), lateral branch diameters (1 cm beyond the tree trunk), lateral branch angles (between the lateral branches and tree trunk), first branch height (from the ground to the first branch) were investigated in 8 plants in each replication at the end of

November 2013. At the harvest time (May 15 - June 15, 2015), fruit yield per plant, mean fruit weight, mean fruit diameter, number of fruits per plant, and fruit-bearing tree rates were investigated. The number of flowers per plant (for the second year; because of hail damage in the first year) was investigated in May 2016.

The experimental setup was a randomized complete blocks design with 8 plants per replication (3 replications per treatment: 24 plants per treatment). The experimental data were collected and subjected to analysis of variance using SPSS (IBM) 23.0 software. The means were separated by Duncan's multiple comparison test at $p \leq 0.05$.

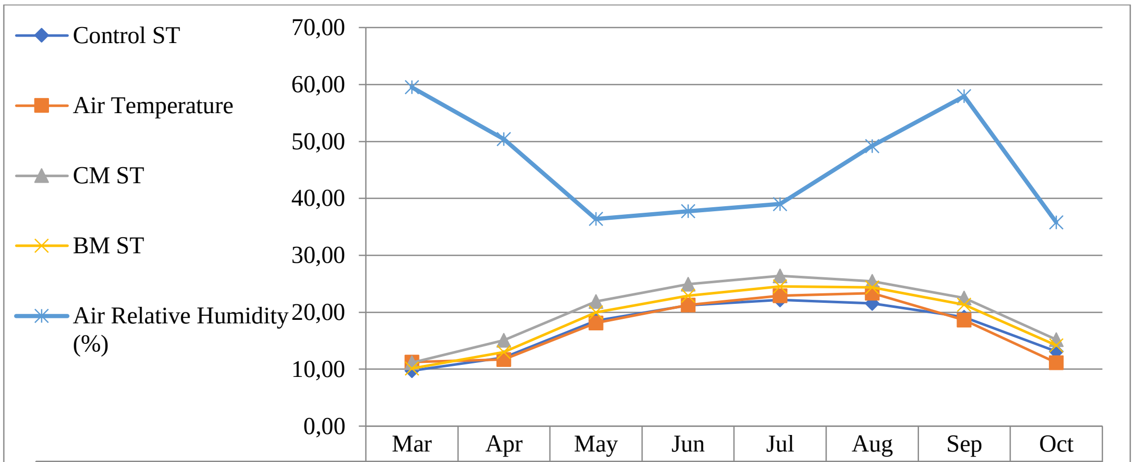
3. Results and Discussion

3.1. Average Soil Temperatures (AST)

Soil temperature was measured by a digital soil thermometer. According to the results (Figure 1), CM treatment has shown the highest soil temperature followed by BM treatment. The AST of mulch treatments was higher than the control. Accordingly, the average soil temperature on CM treatment (March: 11.12^{o}C, April: 15.08^{o}C, and May: 21.91^{o}C) was higher than BM and control. When previous studies were examined, similar to this study, clear mulch increased the soil temperature more than black mulch (19,20,21). However, the extreme increase in AST in summer (June: 24.95^{o}C, July: 26.37^{o}C, and August: 25.44^{o}C) caused by CM may have adversely affected plant development. As can be seen below, CM has been less effective on the lateral branch and fruit development than the BM, despite the high AST.

3.2. Plant Features

Statistically significant (p: 0.05) differences were obtained for CM and BM treatments on all plant features evaluated (Table 1). But, CM and control treatments were in the same groups for the height of the first branch. The height of the CM-treated plants was higher than the control by 126.58 cm, but it was in the same statistical group as BM-treated plants (125.96 cm). BM and CM treatments had many positive effects on branch induction and plant height. According to Tromp (22), high soil temperature at the early stages of plant growth improves plant height, while high soil temperatures at the late growth stages do not affect plant height effectively. Even though CM treatment increased soil temperature highly at the late plant growth stages, BM treatment did not increase soil temperature as much as the CM treatment. Because of that, the tree height of the CM-treated plants may have been negatively affected by high temperature.



	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Control ST	9,73	12,05	18,52	21,19	22,15	21,55	19,12	13,13
Air Temperature	11,25	11,70	18,15	21,26	22,91	23,38	18,65	11,16
CM ST	11,12	15,08	21,91	24,95	26,37	25,44	22,50	15,18
BM ST	10,11	13,02	19,96	22,91	24,53	24,37	21,35	14,19
Air Relative Humidity (%)	59,53	50,40	36,40	37,75	39,00	49,20	57,95	35,80

Figure 1. Soil and air temperatures (ºC) with relative humidity (%) by months in 2013

The BM treatment caused the thickest trunk diameter (18.42 mm) followed by CM (17.58 mm) and control (12.85 mm) (Table 1). Mulch treatments increased plant diameter positively compared to the control treatment. There are many studies regarding the effect of branching treatments on plant diameter. According to some previous reports, branching treatments do not affect plant height and diameter (23,24,25,26,27,28), while some other studies reported a positive effect of branching treatments on plant height and diameter (29). At the same time, Hrotko et al. (30) reported that branching treatments do not affect plant height positively, while according to Gürz (31) branching treatments affect plant height and diameter differently depending on species and cultivars.

The BM-treated plants with 75.57 cm branching height showed the maximum height of the first branch (HFB) (Table 1). It was followed by control (64.97 cm) and CM (64.37 cm) treatments. Volz et al. (32) reported that the height of the first branch should be a minimum of 50 cm for fruit trees. According to Sazo and Robinson (33), Tiberon (cyclanilide) treatments reduce HFB in some apple cultivars. On the contrary, promalin increases HFB compared to control and cutting treatments (34). In this study, BM treatment increased HFB, while CM treatment did not have any effect. It may be caused by high soil temperature at the late growth stage in the CM treatment.

Table 1. Effects of branching treatments on some plant characteristics*

Treatments	Plant Height (cm)	Plant Diameter (mm)	The Height of the First Branch (cm)
Control	100.17^{b}	12.85^{c}	64.97^{b}
Clear Mulch	126.58^{a}	17.58^{b}	64.37^{b}
Black Mulch	125.96^{a}	18.42^{a}	75.57^{a}
p	0.000	0.000	0.000

* There is no difference between the averages indicated by the same letter in the same group at the 0.05 level

3.3. Branching Features

The effect of mulch treatments on branching features was found statistically significant (p: 0.05). While the number of lateral branches (NLB) per tree was the highest on BM-treated plants (1.71 lateral branches (lb) per tree), the control had a lower NLB with 0.84 lb per tree (Table 2). Besides, the CM treatments had 1.29 lb per tree. The effect of perlan on lateral branch formation is well-characterized, especially in apple and pear species. There are many reports on lateral branching in fruit tree saplings using perlan. Many of them reported increased lateral branch formation in fruit trees with bioregulator treatment such as perlan (7,15,18,22,25,32,33,34,35,36,37,38,39,40,41,42). Besides, the effect of soil temperature and humidity on the number and length of the lateral branches was also reported (22,43,44). The results obtained from this study were similar to previous observations. Increased soil temperature caused by mulch treatments positively affected NLB. However, branching was found low in CM treatment, compared to BM. This may be due to elevated soil temperature during the late growth stage. According to Tromp (22), high soil temperature and low relative air humidity during the late growth stages adversely affect the formation of lateral branches. In this study, high soil temperature and low relative humidity observed in July, August, and September may have reduced sufficient branch formation in CM treatment.

Table 2. Effects of branching treatments on some branching characteristics

Treatments	The Lateral Branch Number	The Lateral Branch Length (cm)	The Lateral Branch Diameter (mm)	The Lateral Branch Angle (°)
Control	0.89^{c}	24.61^{c}	4.32^{c}	31.72^{c}
Clear Mulch	1.29^{b}	26.07^{b}	6.36^{b}	44.59^{b}
Black Mulch	1.71^{a}	27.23^{a}	6.73^{a}	48.50^{a}
p	0.000	0.000	0.000	0.000

*There is no difference between the averages indicated by the same letter in the same group at the 0.05 level

When the effects of treatments on branch length were examined, mulch treatments positively affected lateral branch length (Table 2). The effects of treatments on lateral branch length (LBL) were 27.23 cm for BM, followed by 26.07 cm for CM and 24.61 cm for control. According to Bennewitz et al. (41) and Yıldırım et al. (34), branching treatments increase the LBL, on the other hand, Sazo and Robinson (33) reported a negative effect, and Cody et al. (25) reported that branching treatments do not affect the LBL. However, the above-mentioned investigators agree that branching treatments positively affects total branch length. It is evident that the total number of branches, hence the branch lengths are high in studies where branching treatments are said to reduce or not affect the LBL. At the same time, Tromp (22) reported that increased soil temperature positively affects the LBL. Similar results were found in this study. Although the soil temperature provided by CM treatment was higher than the BM treatment, average LBL was found lower in CM. It may be caused by excessively high soil temperatures at the middle and late growth stages.

When the effects of treatments on branch diameter were examined, the mulch treatments had positive effects on lateral branch diameter (LBD). The CM, BM, and control treatments were in different statistical groups (p: 0.05) according to the Duncans multiple comparison test (Table 2). The highest LBD was obtained from BM treatment (6.73 mm), followed by CM treatment (6.36 mm), and the lowest LBD was obtained from control (4.32 mm). In LBD, treatments have shown similar results to LBL and it may be caused by mulch treatments, because of their positive growth effects on lateral branches. Eren (28) applied branching treatments such as perlan, regalis, and removing young leaves on young sweet cherry trees and found that the perlan increases the LBD. Additionally, Tromp (22) noted that increases in soil temperature during the early growth stage increased plant growth. This study has similar results to those mentioned above in LBD.

When the effect of branching treatments on lateral branch angle (LBA) was examined, it was seen that mulch treatments caused wider branch angles (Table 2). The highest LBA was obtained from BM treatment (48.50^{o}), followed by CM treatment (44.59^{o}) and the lowest LBA was found in the control treatment (31.72^{o}). The majority of researchers aiming to increase the number of lateral branches in fruit trees reported that branching treatments increased the lateral branch angle (31,32,34,39,42,45,46). At the same time, some others reported that branching treatments decrease LBA (33,47,48). In addition, Wertheim and Estabrooks (38) reported that LBA may be affected by doses of plant growth regulators intended for branching, such as benzyl adenine. However, in this study, LBA was found much higher in BM treatment than in control. The LBA may be increased by mulch treatment.

3.4. Fruit Characteristics

In terms of fruit characteristics (yield per plant, number of fruits per plant, mean fruit weight, and fruit diameter), the difference between the treatments was found statistically significant (p:0.05) (Table 3). The BM treatment maximized the fruit yield per plant (79.77 g). However, CM (15.50 g) treatment did not increase fruit yield per plant as much as BM treatment when compared with control

(3.04 g). According to Şahin (49) and Şahin et al. (50), fruit production in the orchards established with well-branched trees can start earlier than in the orchards established with unbranched trees. The above-mentioned results are similar to the results of fruit characteristics obtained from this study. The high yield obtained may be due to well-branched, well-developed, and well-rooted plants with the positive effect of mulch treatments (especially black mulch).

Table 3. Effects of branching treatments on some yield and fruit characteristics in the first yield year

Treatments	Yield Per Plant (g)	Number of Fruit Per Plant	Mean Fruit Weight (g)	Fruit Diameter (mm)
Control	3.04^{c}	0.57^{c}	5.31^{b}	21.33^{c}
Clear Mulch	15.50^{b}	2.67^{b}	5.82^{b}	22.30^{b}
Black Mulch	79.77^{a}	11.80^{a}	6.79^{a}	23.38^{a}
p	0.000	0.000	0.000	0.000

* There is no difference between the averages indicated by the same letter in the same group at the 0.05 level

It has been determined that the mulch treatments have a positive effect when the number of fruits per plant is taken into consideration (Table 3). The highest number of fruits per plant was obtained from BM treatment (11.80). At the same time, the lowest was obtained in the control (0.57). Furthermore, CM (2.67) did not increase the number of fruits per plant sufficiently when compared to BM. It can be affected by elevated soil temperature in the middle and late growth stages.

As for the effects of mulch treatments on mean fruit weight, the difference between the treatments was found statistically significant (p: 0.05) (Table 3). The treatment which maximized the mean fruit weight was BM (6.79 g). Although CM (5.82 g) also increased the fruit weight compared to control (5.32 g), it was not as effective as BM. The increase in mean fruit weight caused by mulch treatments may be due to increased root development along with increased soil temperature. However, limited mean fruit weight increases in CM treatment may be due to elevated soil temperature in the medium and late growth stages.

The BM (23.38 mm) treatment maximized the fruit diameter, and CM (22.30 mm), appears to increase fruit diameter when compared to the control (21.33 mm) is not as effective as BM (Table 3). The reason for increased fruit diameter by mulch treatments may be due to better plant nutrients provided by roots (more produced depending on the increase in soil temperature).

When the effect of mulch treatments on the RTWBF was examined, it was seen that the treatments led to different results (Table 4). This may be the reason (which are also referred to by Şahin (49) and Şahin et al. (50)) that the mulch treatments (which increase the plant development and branch formation) may lead to early fructification in the fruit trees.

Table 4. Effects of branching treatments on bearing and flowering characteristics in second yield year

Treatments	Fruit Bearing Tree Rate	Number of Flowers Per Plant
Control	2.0/7.0	34.01[c]
Clear Mulch	4.3/7.0	83.67[a]
Black Mulch	6.0/7.0	52.48[b]
p		0.000

* There is no difference between the averages indicated by the same letter in the same group at the 0.05 level

According to the numbers of flowers in the second fruit year (fruit could not be obtained due to hail damage), CM treatment (83.67 per plant) produced more flowers in the second year than BM treatment (52.48 per plant) (Table 4). This may be due to the relatively low bud formation of CM-treated plants in the previous year.

4. Conclusions

Mulch treatments with a high potential for high-quality fruit production may be a good alternative to chemical substances used for fruit tree branching. Especially with the use of black mulch, high-quality and branched fruit seedlings can be produced. However, since the use of clear mulch increased the temperature of the soil too much during the medium and late growth stages, the saplings and fruit characteristics were not as favorable as the black mulch. Since increased soil temperature negatively affects plant development and branching during medium and late growth stages, new studies can be performed with earlier mulch treatments and removal in the spring.

References

1. Rehder A. Manual of cultivated trees and shrubs. 2nd ed. Ed.: New-York, Macmillan Compagny USA, pp.452–481; 1947.
2. Webster AD, Looney NE, Kupferman EM. 1st Ed. Salzhausen: CAB International; 1996. Harvest and handling sweet cherries for the fresh market; p.411-414.
3. Webster AD, Looney NE. Cherries: Crop physiology, production and uses. 1st ed. Salzhausen: CAB International Germany, pp.25-69; 1996.
4. Davis PH. Flora of Turkey and the East Aegean Islands. 4th ed. Edinburg, Edinburg Univ Press UK; 1972.
5. Food and Agriculture Organization of the United Nations. Statistics. [Internet] 2018 [updated 2018 Jun 01; cited 2018 May 06]; Available from: http://www.fao.org/faostat/en/#data/QC
6. Buban T. The use benzyladenine in orchard fruit growing: a mini review. Plant Growth Regulation 2000;32:381-390.
7. Gastol M, Poniedzialek W. Induction of lateral branching in nursery trees. Electronic Journal of Polish Agriculture Universities: Horticulture 2003;6(2):8-14.

8. Magyar L, Barancsi Z, Dickmann A, Hrotko K. Application of bio-stimulators in nursery. Bulletin of the University of Agricultural Sciences & Veterinary Medicine Cluj-Napoca. Horticulture 2008;65(1):515.
9. Quinlan JD. The use of growth regulators for shaping young fruit trees. In: 1978 Symposium on Growth Regulators in Fruit Production, 2017 September 16-21; Skierniewice.
10. Johann G. Effect of growth regulators on branching habit of some apple cultivars in the nursery. In: 1983 XXI. Symposium on Growth Regulators, 2017 July 1-6; Hamburg.
11. Hrotko K, Magyar L, Öri B. Improved feathering on one-year-old 'Germersdorfi FL 45' Sweet Cherry trees in the nursery. Gartenbauwissenschaft 1999;64(2):75–78.
12. Taiz L, Zeiger E. 4th ed. Sunderland: Sinauer Associates; 2008. Chapter 21, Cytokinins: Regulators of cell division; p.493-517.
13. Leyser O. Regulation of shoot branching by auxin. Trends in Plant Science 2003;8(11):541–545.
14. Dun EA, Ferguson BJ, Beveridge CA. Apical dominance and shoot branching. divergent opinions or divergent mechanisms? Plant Physiology, 2006;142:812–819.
15. Ongaro V, Leyser O. Hormonal control of shoot branching. Journal of Experimental Botany 2008;59(1):67-74.
16. Ferguson BJ, Beveridge CA. Roles for auxin, cytokinin, and strigolactone in regulating shoot branching. Plant Physiology 2009;149:1929-1944.
17. Brewer PB, Dun EA, Ferguson BJ, Rameau C, Beveridge C. Strigolactone acts downstream of auxin to regulate bud outgrowth in pea and Arabidopsis. Plant Physiology 2009;150:482–493.
18. Shimizu-Sato S, Tanaka M, Mori H. Auxin–cytokinin interactions in the control of shoot branching. Plant Molecular Biology 2009;69(4):429-435.
19. Abak K, Pakyürek AY, Sarı N. Malç ve alçak tünel uygulamalarının serada yetiştirilen biberin erkenciliği, verimi ve kök gelişimi ile toprak sıcaklığı üzerine etkileri. Çukurova Üniversitesi Ziraat Fakültesi Dergisi 1992;7(1):1-12.
20. Preece JE, Read PE. The Biology of Horticulture: an introductory textbook. 2nd ed.New York: John Wiley & Son USA; 2005.
21. Libik A, Siwek P. Changes in soil temparature affected by the application of plastic covers in field production of lettuce and watermelon. In: 1994 VII International Symposium on Timing Field Production of Vegetables, 1994 Aug 23-28; Skierniewice.
22. Tromp J. Sylleptic shoot formation in young apple trees exposed to various soil temperature and air humidity regimes in three successive periods of the growing season. Annals of Botany, 1996;77(1):63-70.
23. Baldini E, Sansavini S, Zocca A. Feather ınduction by growth regulators on maiden trees of apple and pear. Acta Horticulturae 1973;34:117-122.
24. Quinlan JD, Preston AD. Chemical induction of branching in nursery trees. In: 1973 Symposium on Growth Regulators in Fruit Production, 1973 Aug 26-30; Minnesota.
25. Cody CA, Larsen FE, Fritts RJ. Stimulation of lateral branch development in tree fruit nursery stock with GA_{4+7}+6-BA. Hortscience 1985;20(4):758–759.
26. Keever GJ, Foster WJ, Olive JW, West MS. Increasing 'Bradford' pear crotch angles and lateral shoot counts with benzyladenine or promalin sprays. HortScience 1993;28(6):678-678.
27. Rossi AD, Rufato L, Giacobbo GL, Gomez FRC, Fachinello JC. Use of promalin on one-year-old trees of the apple cv.'Catarina'. In: 2004 XXVI International Horticultural Congress: Key Processes in the Growth and Cropping of Deciduous Fruit and Nut Trees, 2004 Aug 11-16, Toronto.
28. Eren G. Fidanlık koşullarında kiraz fidanlarının dallandırılması [MD Thesis]. Kahramanmaraş: Sütçü İmam Üniversitesi; 2012.
29. Koyuncu F, Yıldırım AN. Induction of lateral branching of '0900 Ziraat' sweet cherry in the nursery with GA_{4+7}+6-Benzyladenine. In: 2008 Proceedings of V. International Cherry Symposium, 2008 Aug 31-Sep 7; Bursa.
30. Hrotko K, Magyar L, Buban T. Improved feathering by benzyladenine application on one-year-old 'Idared' apple trees in the nursery. In: 1997 Proceedings of the VI. International Symposium on

Integrated Canopy, Rootstock, Environmental Physiology in Orchard Systems, 1997 Nov 1-7; Wenatchee.
31. Gürz A. Dışsal benziladenin uygulamasının bodur elma fidanlarının dallanması üzerine etkisi [MD Thesis]. Kahramanmaraş: Sütçü İmam Üniversitesi; 2005.
32. Volz RK, Gibbs HM, Popenoe J. Branch induction on apple nursery trees: Effects of growth regulators and defoliation. New Zelland Journal of Crop and Horticultural Science 1994;22(3):277-283.
33. Sazo MM, Robinson TL. The use of plant growth regulators for branching of nursery trees in NY state. New York Fruit Quarterly 2011;19(2):5-9.
34. Yıldırım AN, Koyuncu F. The effect of gibberellic acid applications on the cracking rate and fruit quality in the 0900 Ziraat sweet cherry cultivar. African Journal of Biotechnology, 2010;9:6307-6311.
35. Greene DW, Autio WR. Vegetative responses of apple trees following benzyladenine and growth regulator sprays. Journal of the American Society for Horticultural Science 1990;115(3):400-404.
36. Jacyna T. Studies on natural and chemically induced branching in temperate fruit and ornamental trees. Rozprawy Naukowe. Akademia Rolnicza w Lublinie, 2001;246:1-124.
37. Ouellette DR, Young E. Branch inducement in apple stoolbed shoots by summer leaf removal and tipping. HortScience 1994;29(12):1478-1480.
38. Wertheim SJ, Estabrooks EN. Effect of repeated sprays of 6-benzyladenine on the formation of sylleptic shoots in apple in the fruit-tree nursery. Scientia Horticulturae 1994;60(1-2):31-39.
39. Elfving DC, Visser DB. Cyclanilide induces lateral branching in apple trees. Hortscience 2005;40 (1):119-122.
40. Veit B. Hormone mediated regulation of the shoot apical meristem. Plant Molecular Biology, 2009;69(4):397-408.
41. Bennewitz E, Fredes C, Guitierrez L, Losak T. Effect of the co-application of Promalin at different bud phenological stages and notching at different distances on lateral branching of three sweet cherry cultivars (*Prunus Avium* L.) in central Chile. Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis 2010;58(2):45-50.
42. Bektaş M, Ersoy N. Branch induction on apple (*Malus domestica* L.) nursery trees: Effects of perlan (GA_{4+7}+6-BA) and pinching. Journal of Food, Agriculture & Environment 2010;8(3-4):651-654.
43. Tromp J. Lateral shoot formation in apple in the first year after budding as affected by air humidity and soil temperature. In: 1992 I. International Symposium on Training and Pruning of Fruit Trees, 1992 Oct 1-7; Sheprdstown.
44. Tromp J. The effect of soil temperature on lateral shoot formation and flower-bud formation in apple in the first year after budding. Journal of Horticultural Science, 1992;67(6):787-793.
45. Williams MW, Billingsley HD. Increasing the number and crotch angles of primary branches of apple trees with cytokinins and giberellic acid. Journal of the American Society for Horticultural Science, 1973;95:649-651.
46. Faust M. Physiology of temperate zone fruit trees.1st ed. New York: John Wiley & Sons USA; 1989.
47. Plich H, Jankiewicz L. Application of gibberellin and cytokinin in crown formation of apple trees. Acta Agrobotanica 1973;26(2):257-264.
48. Cmelik Z, Tojnko S. Inducement of sylleptic shoots in apple in the fruit tree nursery. Pomologia Croatica 2005;11(3/4):155-166.
49. Şahin M. Effects of promalin and mulch on lateral branching in sweet cherry [MD Thesis] Konya: Selçuk Üniversitesi; 2015.
50. Şahin M, Eşitken A, Pirlak L. Effects of mulch treatments on lateral branching of sweet cherry trees. In: 2017 52. Croatian and 12. International Symposium on Agriculture, 2017 Feb 12-17; Dubrovnik.