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Research Article

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Prunus avium L., earliness, fruit diameter, full bloom, foliar application

Determining The Effects of Different Treatments on The Flowering of Sweet Cherry Trees and Fruit Quality

Abstract

Earliness is also very important in addition to yield and fruit quality for more profitable production in sweet cherry cultivation. Therefore, some preparats are applied to get flowering even earlier in Kemalpaşa District of Izmir province, where sweet cherry fruits from Turkey are harvested the earliest. In this study, it was aimed to determine the effects of different treatments in the pre-flowering period on flowering and fruit quality of sweet cherry fruits. The study was carried out in the 2018 production year in a sweet cherry orchard established with the "0900 Ziraat" (*Prunus avium* L.) variety grafted on the "idris" (*Prunus mahaleb*) rootstock belonging to a producer in Kemalpaşa district of Izmir province. Approximately 30 days before flowering, Bud Feed 20 (BF20), 40 (BF40) and 60 mL L^{-1} (BF60) doses with Sett (3 mL L^{-1}), Erger (50 mL L^{-1}) + $CaNO_3$ were treated to the sweet cherry trees from the leaf. The trees that are sprayed only with water were considered as control. Branches of similar size were selected from 4 different directions of the trees to determine flowering in sweet cherry trees, and the number of flowers bloomed on the branches recorded for 2-day intervals from March 17, when the first flowering was observed until the flowering was completed. The sweet cherry trees treated with BF40 + Sett, BF60 + Sett, and Erger + $CaNO_3$ had the flowering 6-7 days and full bloom 7-8 days before compared to the control trees. The last flowering time of BF60 + Sett treated sweet cherry trees was 8 days earlier than the control trees, and 6 days earlier than the other treatments. It was determined that the weight and diameter of the fruits in BF60 + Sett and Erger + $CaNO_3$ treated sweet cherry trees were partially higher than the control, while the other quality parameters were similar. The results showed that BF60 + Sett, Erger + $CaNO_3$ and BF40 + Sett treatments were effective in the early flowering of sweet cherry fruits.

INTRODUCTION

Since sweet cherry fruits are marketed at a higher price in the early period, earliness is of great importance. Depending on temperatures, full bloom generally occurs between 3 and 6 weeks after bud burst, depending on temperature (Sterling, 1964). Kemalpaşa district of Izmir province located in western Turkey is the region where sweet cherry fruits are harvested at the earliest (first week of May), in Turkey (Erogul, 2016). Achieving the flowering to happen earlier on sweet cherry trees is one of the top priorities of the sweet cherry-growing producers in this region therefore some preparats are being applied or cultivation methods are being tried. However, there is no detailed and comprehensive scientific study on how early the preparats, stated to provide this effect, bring the flowering in sweet cherry trees in this region. Cultural practices can also affect early flower differentiation. Early summer pruning in the current season growth can advance the initiation of flower buds (Guimond et al., 1998; Herrero et al., 2017).

Fruit size is an important parameter in the marketing of sweet cherry fruits, and unit sales prices also increase significantly as the size increases, especially in exports (Whiting et al., 2005; Sen et al., 2014). Therefore, increasing the size of fruits besides earliness is one of the priority issues in sweet cherry cultivation (Olmstead et al., 2007). Following fertilization, fruit growth proceeds rapidly, and begin developing into fruit (Hedhly et al., 2007). As in other *Prunus* spp., sweet cherry fruit growth follows a double sigmoid curve (Coombe, 1976). Since the whole harvest method is generally preferred for the sweet cherry fruits, all fruits of different sizes on the tree are harvested at once (Karaçalı, 2016; Whiting and Perry, 2017). The length of the flowering period plays an important role in the difference observed on the fruit size in the tree. Full bloom time and flowering time in sweet cherry trees vary according to variety, ecology, and maintenance work. Above-average air temperatures cause the full bloom time to happen earlier, shortening the flowering time and ripening period. In fruit trees, the fruits with flowering first are bigger in size because they are better fed, while the ones that flower the later are smaller. The difference between fruit sizes becomes more pronounced as the flowering period is prolonged in the periods with cold temperatures (Thompson, 1996; Guerra and Rodrigo, 2015). Therefore, keeping the flowering period short, especially in years when climatic conditions are not suitable, is even more important for obtaining homogeneous sweet cherry fruit (Whiting and Ophardt, 2005; Lenahan et al., 2006). For this purpose, treatments that would shorten the flowering time of sweet cherry trees are of great importance for production with homogeneous fruit size.

In this study, it is aimed to determine the effects of treatments before the flowering period on the flowering of the cherries and the quality of the fruit. With the counts and the evaluations made during the flowering period, it is aimed to determine the full bloom period, flowering time, fruit size, yield, and some physical and chemical properties of sweet cherry fruits.

MATERIAL and METHODS

Material

The study was carried out in the 2018 production year in a sweet cherry orchard established with the "0900 Ziraat" (*Prunus avium* L.) variety grafted on the "idris" (*Prunus mahaleb*) rootstock belonging to a producer in Kemalpaşa district of Izmir province. Pruning, tillage, nutrition, control of diseases and pests of the sweet cherry trees were performed as standard practices (Özçağıran et al., 2003).

Treatments

About 30 days before commencement of flowering , 5 different treatments such as 1) Control, 2) Bud Feed (20 mL L^{-1})+Sett (3 mL L^{-1}), 3) Bud Feed (40 mL L^{-1})+Sett (3 mL L^{-1}), 4) Bud Feed (6 L $100L^{-1}$)+Sett (300 L $100L^{-1}$), 5) Erger (50 L $100L^{-}$

^{1})+$CaNO_3$ (75 g L^{-1}) were performed on the leaves of the sweet cherry trees. Those only sprayed with water were considered as controls. The treatments were conducted just before the evening with a back pulverizator so that the crown of each tree is completely wetted. Sticking-extending adjuvant (%0.04 Nu-Film-17®, Miller Chemical Corp., USA) is added to the solution used in all treatments.

The study was established in 6 replications according to the random blocks experimental design, and each tree was considered a repetition.

Detection of flowering

In order to detect the flowering in sweet cherry trees, branches of similar size were selected from 4 different directions of each tree in all the treated trees. Sweet cherry trees in the parcel where the application was made close to the flowering period were monitored, the number of flowers that bloomed in all trees selected for 2-day intervals starting on March 17, 2018, when the first flowering was observed, was detected and recorded. These counts continued until April 6, 2018, when all flowers on all selected branches bloom.

Measurement and analysis of the flowering period

Beginning of flowering: The date when 10% of the flower buds open is considered as the flowering commencement date.

Full bloom: In some studies, the full bloom time has been considered as the date when more than 80% of the existing flower buds in sweet cherry trees open.

End of flowering: The date when 95% of the flowers in sweet cherry trees bloom is considered the end of flowering.

Effective flowering period: The period between the flowering commencement and the full bloom (when more than 80% blooms) in sweet cherry trees is considered as the effective flowering period.

Flowering time: The period between the flowering commencement and the end of the flowering of the sweet cherry trees was accepted as the flowering time.

Measurements and analyses during the harvest period

Fruit weight: The average fruit weight (g) will be determined by dividing the total weights of the sweet cherry fruits, which are measured with precision scales, by the total number of fruits.

Width and length of fruit: The width and length of 80 fruits that will be taken randomly from fruits harvested from different directions of each tree would be measured with a digital caliper sensitive to 0.01 mm.

Fruit color: Fruit color was measured in CIE L*, a*, b* with a Minolta colorimeter (CR-400, Minolta Co, Japan) from the equatorial region of 20 sweet cherry fruits taken from each repeat. The device will be calibrated with the standard white calibration plate (L * = 97.26, a * = + 0.13, b * = + 1.71) before measurements. Chroma (C*) and hue angle (h^o) values were calculated from the obtained a* and b* values (McGuire, 1992).

$C^*= (a^{*2}+b^{*2})^{1/2}$ $h^o= \tan^{-1} (b^*/a^*)$

Amount of Total Soluble Solids (TSS): The amount of TSS was determined by digital refractometer (PR-1, Atago, Japan) from a few drops of fruit juice obtained by squeezing the sweet cherry fruits by hand, and the results were expressed as % (Karaçalı, 2016).

Amount of Titratable acidity (TA): TA amount was calculated from the amount of NaOH consumed by titrating 10 ml of sweet cherry juice with 0.1 N NaOH to pH 8.1 and expressed as g malic acid 100 mL^{-1} (Karaçalı, 2016).

The pH value: The pH value of the juice of the fruit was determined with the pH meter (MP220, Mettler Toledo, Germany).

Statistical analysis

The quality data obtained from the experiment were subjected to variance analysis using IBM® SPSS® Statistics 19 (IBM. NY. USA) statistical package program. Differences between means were determined by the Duncan test ($P \leq 0.05$).

RESULTS

Beginning of Flowering

According to different treatments in the pre-flowering period, the flowering commencement of sweet cherry trees is presented in Table 1. The effects of treatments on the flowering commencement (10% of them started the bloom) have been significant. It was determined that the flowering commencement was on 19.03.2018 in sweet cherry trees treated with BF40+Sett, on 21.03.2018 in those treated with BF60+Sett and Erger+$CaNO_3$ and on 27.03.2018 in control trees (Table 1, Figure 1).

Table 1. Flowering status of sweet cherry trees that were applied with different treatments before flowering

Treatments	Flowering time										
	17.03	19.03	21.03	23.03	25.03	27.03	29.03	31.03	02.04	04.04	06.04
Control	0.00	0.00	1.13	4.06	9.64	25.04	49.54	73.25	93.03	98.10	100.00
BF20+Sett	0.00	0.00	0.06	6.61	23.64	76.97	96.72	99.34	100.00	100.00	100.00
BF40+Sett	0.73	10.19	23.46	47.49	73.23	90.37	97.25	98.59	99.89	100.00	100.00
BF60+Sett	0.59	9.05	26.15	59.12	80.06	95.15	98.06	98.48	100.00	100.00	100.00
Erger+$CaNO_3$	0.06	2.50	21.05	59.99	80.53	92.32	96.84	98.71	99.76	99.90	100.00

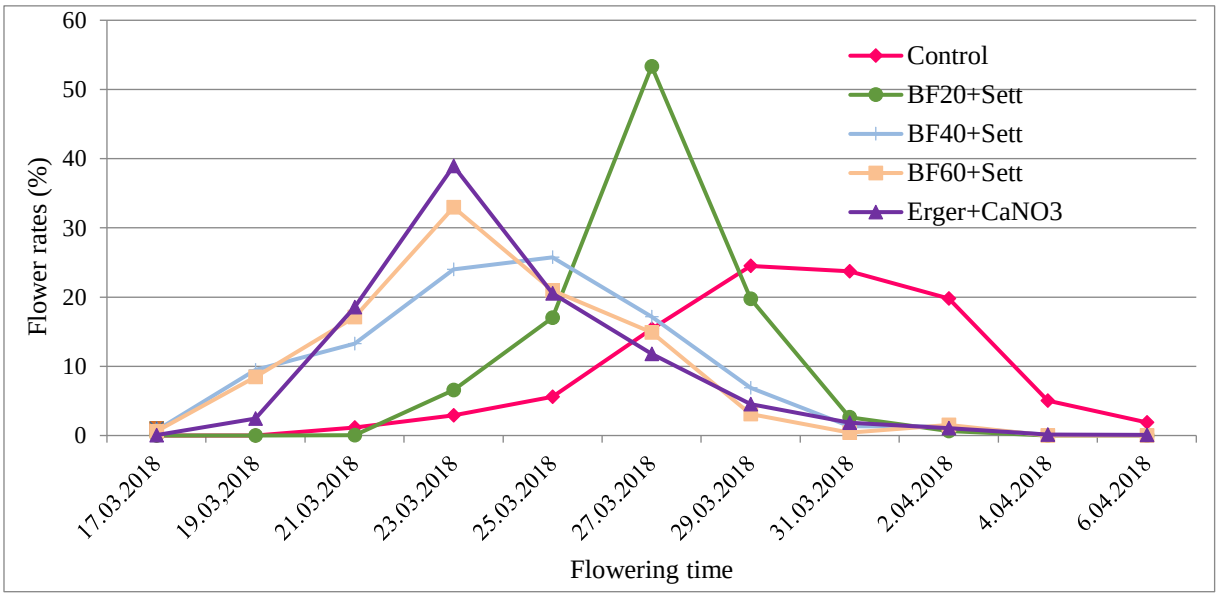

Figure 1. The rates of flower during the time of the flowering period according to the treatments

Full Bloom

The effect of the treatments on the "full bloom" time when more than 80% of the flowers of sweet cherry trees bloom has been significant. Sweet cherry trees treated with Erger+$CaNO_3$ and BF60+Sett reached full bloom on 25.03.2018, while control trees reached full bloom on 02.04.2018. In sweet cherry trees with BF40+Sett treatment, the full bloom took place on 27.03.2018 which was closer to the time of early groups. On the other hand, the full bloom of sweet cherry trees with BF20+Sett treatment happened on 29.03.2018 (Table 1, Figure 1).

Last Flowering Time

The time when the sweet cherry trees reached their last flowering varied significantly according to the treatments. BF60+Sett treated sweet cherry trees last flowering time (95% of flowering) was detected as 27.03.2018, while as 04.04.2018 for control trees. BF40+Sett, Erger+$CaNO_3$, and BF20+Sett applied sweet cherry trees

last flowering times were close to those treated with BF60+Sett and detected as 29.03.2018 (Table 1, Figure 1).

Effective Flowering Period

The change in the time between the beginning of flowering and the full bloom (when more than 80% blooms), which is considered an effective flowering period, according to pre-flowering treatments, is presented in Figure 2. The effective flowering period of sweet cherry trees ranged from 5 to 9 days. Sweet cherry trees treated with BF20+Sett, BF60+Sett, and Erger+$CaNO_3$ had an effective flowering period of 5 days, while 7 days for control and 9 days for BF40+Sett treated sweet cherry trees.

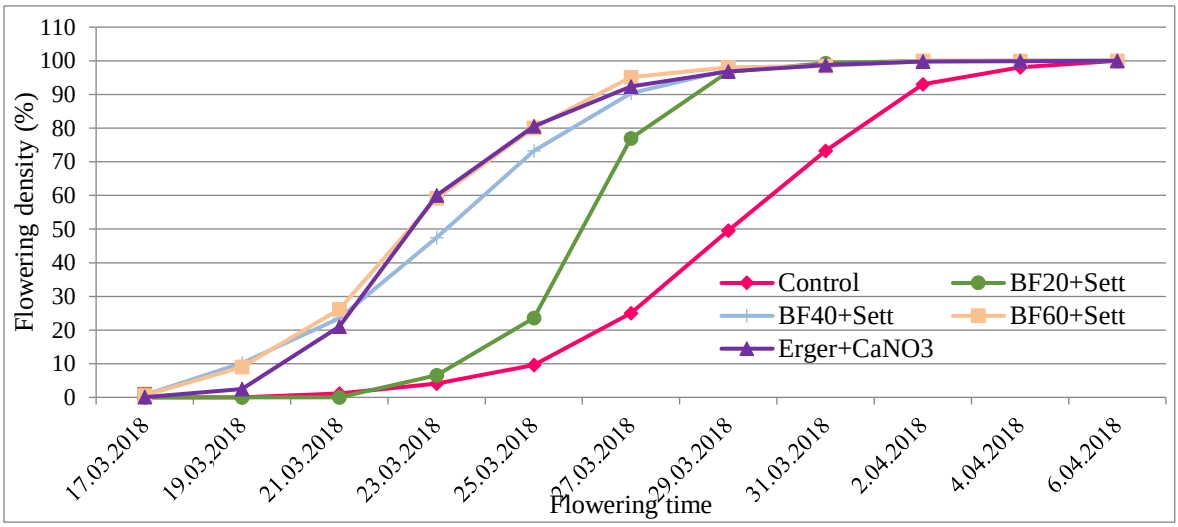

Figure 2. Effects of different treatments on the effective flowering period of cherry trees

Flowering time

The flowering time of sweet cherry trees varied between 5 and 11 days depending on the treatments. The flowering time of BF20+Sett treated sweet cherry trees was determined as the shortest with 5 days. It was followed by the BF60+Sett treatment with a 7-day flowering period. The flowering period was determined as 9 days both in control and sweet cherry trees treated with Erger+$CaNO_3$, while 11 days for BF40+Sett treated trees (Table 1, Figure 2).

Fruit quality

The weight, diameter, length, TSS, TA content, and pH values of sweet cherry fruits according to the treatments are given in Table 2. While the effect of different treatments on sweet cherry trees carried out before flowering on fruit weight and diameter were found statistically significant ($P \leq 0.05$), the effect on other parameters investigated was not significant. BF60+Sett and Erger+$CaNO_3$ treatments increased the weight of sweet cherry fruits, it was detected as 10.69 g and 10.51, respectively. Sweet cherry fruit average weight in these treatments was found to be 22.8% higher than the control.

The diameter of sweet cherry fruits treated with BF60+Sett and Erger+$CaNO_3$ was found to be higher than those in control and the ones treated with BF20+Sett. Fruit diameter was detected as 11.76 mm and 11.56 mm in BF60+Sett and Erger+$CaNO_3$ treated, respectively, while it was 9.49 and 9.46 in control and BF20+Sett treated ones, respectively.

The length of the sweet cherry fruits according to the treatments carried out before flowering. The effects on TSS, TA amount, and pH value were similar to each other, with the values ranging respectively 22.93-24.69 mm, 12.10% -13.70%, 0.38-0.45 g 100 mL^{-1}, and 4.34-4.58.

Table 2. Effects of different treatments carried out on sweet cherry trees before flowering on the fruit weight, diameter, length, TSS, TA content, and pH value

Treatments	Fruit weight (g)	Diameter (mm)	Height (mm)	TSS content (%)	TA content (g/100 mL)	pH
Control	8.63 b*	9.49 b*	22.93^{ns}	13.70^{ns}	0.39^{ns}	4.58^{ns}
BF20+Sett	8.60 b	9.46 b	23.01	12.10	0.45	4.34
BF40+Sett	9.35 ab	10.28 ab	23.63	12.50	0.43	4.34
BF60+Sett	10.69 a	11.76 a	24.46	12.97	0.41	4.45
Erger+$CaNO_3$	10.51 a	11.56 a	24.69	13.23	0.38	4.43

ns, *, Non-significant or significant at $P \leq 0.05$ respectively

Changes of L*, a*, b*, C*, and h° color values of sweet cherry fruits according to the treatments are presented in Table 3. Effects of different treatments carried out on sweet cherry trees before flowering on fruit color showed similarities to each other. L*, a*, b*, C*, and h° color values of sweet cherry fruits were ranging respectively 37.00-39.86, 37.67-40.71, 18.66-22.58, 42.04-46.56, and 26.36-29.01.

Table 3. Effects of different treatments carried out on sweet cherry trees before flowering on fruit color (L*, a*, B*, C*, h°)

Treatments	L*	a*	b*	C*	h°
Control	39.86^{ns}	37.69^{ns}	20.66^{ns}	43.09^{ns}	28.56^{ns}
BF20+Sett	39.29	40.71	22.58	46.56	29.01
BF40+Sett	38.46	38.54	20.41	43.61	27.91
BF60+Sett	38.47	38.28	20.69	43.52	28.39
Erger+$CaNO_3$	37.00	37.67	18.66	42.04	26.36

ns, Non-significant.

DISCUSSION and CONCLUSION

Beginning of flowering (10% of them started the bloom) in sweet cherry trees treated with BF40+Sett, BF60+Sett, Erger+$CaNO_3$ happened 7, 6, and 6 days earlier, respectively, compared to trees in the control. Full bloom happened 8 days before the control in those treated with Erger+$CaNO_3$, BF60+Sett, and 7 days those treated with BF40+Sett. With these three treatments, sweet cherry trees have reached the full blooming period when the flowering of fruit trees is the most intense, a period that can be considered as important as 7-8 days compared to the control. The last flowering in the control trees happened 8 days after the sweet cherry trees treated with BF60+Sett and 6 days after the other treatments. Effective flowering time varied between 5 and 9 days, it was determined that there was no significant difference according to the treatments and the course of flowering was partially similar. Flowering time varied between 5-11 days depending on the treatments. However, flowering time did not show a stable change according to the treatments (Thompson, 1996; Guerra and Rodrigo, 2015). The effect of the treatments on the flowering period can be affected by climatic factors, especially temperature changes. The fact that the temperatures are above average during the flowering period this year has shortened the flowering period in all treatments (Herrero et al., 2017).

It was observed that the floral density of sweet cherry trees treated with BF60+Sett and Erger+$CaNO_3$ happened earlier, and those treated with BF40+Sett were close to these two treatments. The floral density in the control trees was observed to happen later compared to those treated. In general, in all treatments, the flowering rate decreased after reaching a peak. These

peaks happened earlier in sweet cherry trees treated with BF60+Sett, Erger+$CaNO_3$, and BF40+Sett compared to others. According to the treatments, there was a correlation between the change of the peak times and the change of the full bloom times.

The weight and fruit diameter of fruits harvested from sweet cherry trees treated with BF60+Sett and Erger+$CaNO_3$ were detected to be higher than fruits harvested from other treatments. These treatments are thought to be effective in getting the flowering to happen early. Because the weight and diameter of sweet cherry fruits are affected by many factors such as fruit set, nutrition, climatic conditions, maintenance work, harvest time (Sekse, 1995; Crisosto et al., 1995; Mitcham and Crisosto, 2002; Lang et al., 2004; Zoffoli et al., 2008; Karaçalı, 2016; Zoffoli et al., 2017). In the region with earliness in sweet cherry cultivation, producers tend to harvest early. Therefore it is an expected development that the fruits of the trees with early flowering in the harvest period are bigger in size. Because the growth of the fruits with early flowering is better than the ones with late flower commencement (Herrero et al., 2017). Since the size of the sweet cherry fruits is a very important quality parameter, even small differences in fruit diameter are of great importance (Zoffoli et al., 2017). As the fruit size increases in sweet cherry cultivation, the product price increases, which leads to an increase in income (Romano et al., 2006). The effects of the treatments on the height, color, TSS, TA amount, and pH value of sweet cherry fruits were similar. It is an expected development that these treatments, which affect flowering time and duration, have a limited effect on some quality parameters. Because the change of these parameters is closely related to climatic conditions, maintenance work, and harvest time (Mitcham and Crisosto, 2002; Remon et al., 2006; Muskovics et al., 2006; Díaz-Mula et al., 2009).

As a result, the flowering commencement was 6-7 days, the full bloom 7-8 days, and the last flowering 6-8 days earlier in sweet cherry trees treated with BF60+Sett, BF40+Sett, and Erger+$CaNO_3$ compared to control. In these treatments, floral density was reached earlier. While BF60+Sett and Erger+$CaNO_3$ increased the weight and fruit diameter of sweet cherry fruits in the trees where they were applied, their effects on other quality parameters were limited.

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