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Araştırma Makalesi/*Research Article (Original Paper)*

Determination of Effect of Gibberellic Acid Treatments on The Fruit Quality of Strawberry cv. Seascape

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Abstract: In the study, the effect of gibberellic acid treatments on fruit quality of strawberry cv. Seascape grown in Bolu ecological conditions was examined. The fruit quality parameters were identified under the application of two concentration of GA_3 (50 ppm and 100 ppm). It was determined that the values of SSC, pH, TA and fruit hardness were not statistically affected by both GA_3 applications. The highest values related fruit weight and size were obtained at 50 ppm GA_3 application. The SCC and firmness values were determined as 6.67 brix° and 1.31 kg/cm^2 in 100 ppm concentration, respectively. The fruits treated with 50 ppm GA_3 had lower pH than those treated 100 ppm GA_3 and control. In addition, the highest fruit weight (46.01 g) and fruit acidity (1.11%) were obtained at the application of 50 ppm GA_3. It was also found that the GA_3 application did not cause a significant change in the flavor, taste and juice values.

Keywords: Fruit quality, Gibberallic acid, Seascape, Strawberry

Seascape Çilek Çeşidinin Meyve Kalitesi Üzerine Gibberellik Asit Uygulamasının Etkisinin Belirlenmesi

Özet: Bolu ekolojik koşullarında yetiştirilen Seascape çilek çeşidine ait meyve kaliteleri üzerine gibberelik asit uygulamasının etkisi araştırılmıştır. İki konsantrasyonda hazırlanan (50 ppm and 100 ppm) GA_3 uygulamasının meyve kalite parametreleri üzerindeki etkisi belirlenmiştir. SÇKM, pH, toplam asitlik ve meyve sertliği değerlerinin her iki uygulamada da istatistiksel olarak etkilenmediği ve uygulamalar arasında fark bulunmadığı tespit edilmiştir. Diğer kalite parametrelerine ait değerlerin ise en yüksek 50 ppm uygulamasında elde edildiği görülmüştür. Yapılan araştırmada SÇKM ve sertlik değerleri 100 ppm'lik konsantrasyonda sırasıyla 6.67 briks° ve 1.31 kg/cm^2 olarak belirlenmiştir. Kontrol meyveleri en yüksek pH değerine (4.08) sahipken, 50 ppm GA_3 uygulanan meyveler en düşük pH değerine sahip olduğu belirlenmiştir. Buna ek olarak, en yüksek meyve ağırlığı (46.01 g) ve meyve asitliği (% 1.11), 50 ppm GA_3'ün uygulamasında elde edilmiştir. Ayrıca GA_3 uygulamasının aroma, tat ve meyve suyu değerlerinde önemli bir değişime neden olmadığı görülmüştür.

Anahtar kelimeler: Meyve kalitesi, Gibberellik asit, Seascape, Çilek

Introduction

Strawberry (*Fragaria x ananassa* Duch.) cvfruits are among the fruits that are consumed as industrially and freshly. Strawberry production is 8.114.373 tons in the world and Turkey has 375.800 tons of this production. Most of the production is in Mediterranean and Aegean Regions (Anonym 2017a, b). Strawberry fruit is consumed intensely fresh due to its significant effect on health (antioxidant, vitamin C and phenolic compounds), it is also used especially in jams, marmalades and freezes in food industry. It is known that it contains high amounts of vitamin C and phenolic compounds when compared to other fruits and vegetables (Yılmaz 2009). Plant growth regulators affect plant morphology and physiology positively or negatively even at very low doses. The effect of these substances, which may be both promoting and inhibitory, varies according to growth period and species of plant (Eris 1990). They are used to stimulate seed germination, rooting, flowering, fruit set, fruit maturity and fruit color development and to reduce fruit drop and alternate bearing (Çetinbaş 2010). Gibberellins

promote cell division and elongation (Anonym 2017c). They are known to stimulate flowering in herbaceous plant such as strawberries (Blazquez et al. 1997) and control the periodicity by preventing flower buds in fruit trees (Davis 2002). Engin et al. (2007) reported that the application of gibberellin reduced the formation of double fruits in the peach and increased the fruit weight and firmness. In addition, they are said to contribute to the stem elongation, to break seed and apical dormancy, to stimulate germination, to be form seedless fruit if given before flowering, to increase fruit weight if given after flowering (Çetin 2002). Studies on gibberellic acid application in strawberries have found different results. While fruit weight decreased with gibberellic acid application according to Asadi et al. (2013), fruit weight and volume increased according to Saima et al. (2014). Some researchers have reported that the number of runner increases, leaves area and flowering amount decrease when gibberellic acid apply (Eshghi et al. 2012). According to another study, the onset of flowering is delayed but the flowering amount is increased by the application of gibberellic acid. Moreover, it was reported that there were also increases in fruit sizes, weight, yield and water soluble dry matter due to GA treatments (Jamal Uddin et al. 2012; Kumar et al. 2014). The aim of this research was to determine the effect of different doses of gibberellic acid on the fruit quality criteria in the Seascape strawberry cultivar.

Material and Methods

The research was carried out at the Seascape var. strawberry orchard in Mudurnu district of Bolu, in 2016. After the pomological measurements were made, the fruit samples picked homogenously were stored at -80 °C until their laboratory analyses were made. Gibberellic acid was applied the frigo plants, which planted with summer planting, at first flowering and two weeks later in the yielding plants. The doses of 50 ppm and 100 ppm were applied to the leaves as a spray and. no application was made to the control group. (In the fruits obtained during the study; fruit weight (with a balance sensitive to 0.01 g), fruit volume (ml), fruit diameter and length (with a caliper sensitive to 0.01 mm), index, total soluble solids (brix°) (with hand refractometer), pH, titratable acidity (%) (with titration method) and firmness (kg/cm^2) were determined. The flavor, aroma and juice were determined organoleptically (1-5). The experiment was arranged as a completely randomized design with three replications, each plot having 10 plants (3 fruits per plant). Three replications were used for weight, pH and other analyzes, and 10 plants were used in each replicate. Three fruits were taken from each plant and a total of 90 fruit samples were used for each analysis. Data were analyzed by analysis of variance and the means separated by Duncan's Multiple Range Test.

Results and Discussion

In the study was determined difference between the applications in terms of fruit weight. With application, the highest value of fruit weight (46.01 g) was obtained with 50 ppm GA_3 application while the lowest value was determined in the control group (Table 1). Average fruit weight was determined as 42.12 g in the fruits that occurred weight increase with 100 ppm GA_3 application. The effect of gibberellic acid on fruit weight varies according to the investigations. The fruit weight was measured as 13.7 g in the control group showed a weight reduction with 50 and 100 ppm application (13.01 g and 12.33 g respectively) (Eshghi et al., 2012). Similarly, Asadi et al. (2013) indicated that 25 ppm (9.8 g) and 50 ppm gibberellic acid applications (8 g) reduced fruit weight compared control fruits (10.8 g). In contrast, Jamal Uddin et al. (2012) stated that fruit weight increased with gibberellic acid. They stated that this increase was more in the 75 ppm dose application than the 50 and 100 ppm dose applications. In another study, weight increased in strawberries cv Chandler cultivar applied 50, 75 and 100 ppm GA_3 and the maximum increase was determined in the application of 75 ppm GA_3 (17.06 g). The fruit weight, which was 12.44 g in the control group, was expressed as 16.15 g with 50 ppm application and 16.05 g with 100 ppm application (Saima et al. 2014). However, some studies have been in harmony with our work. In this study, it was determined that fruit volume changed with gibberellic acid treatments. The fruit volume was detected in the control group (44.01 ml) and the volume decreased with 100 ppm gibberellic acid application (42 ml). The highest volume was obtained as 51.33 ml with a dose of 50 ppm GA_3 application (Table 1). According to a study made in strawberry, fruit volume showed an increase with application of GA_3. The fruit volume, which was measured as 12.45 ml in the control group, increased by 50,75 and 100 ppm dose application. This increase was measured as maximum (17.11 ml) with 75 ppm gibberellic acid application (Saima ve ark. 2013).

Fruit width and were measured as 41.11 mm and 51.07 mm in the control group, respectively. In the study, the increase was observed in fruit sizes with application of both doses of gibberellic acid. In 50 ppm application, which is determined as the application where the greatest increase is observed, was measured fruit width (46.05 mm) and fruit length (54.35 mm). The highest fruit shape index was determined as 1.16 with 100 ppm GA_3 (Table 1).

Table 1. Effect of GA_3 on fruit weight (g), volume (ml), diameter and length (mm) and index of strawberry cv Seascape

Treatment	Fruit weight	Fruit Volume	Width	Length	Shape İndex
0 ppm	41.20 c*	44.01 b	41.11 c	51.07 b	1.02 a
50 ppm	46.01 a	51.33 a	46.05 a	54.35 a	1.08 a
100 ppm	42.12 b	42.00 b	43.13 b	52.85 ab	1.16 a

*There are significant differences ($p<0.05$) between means indicated same later in same column

In the study, GA_3 application was made in 5 different doses and it was stated that there was an increase in fruit diameter and length in each dose. This increase is expressed as 6.3 % in fruit diameter and 5.2 % in fruit length (Pehluvan et al. 2012). Saima et al. (2014) investigated the effect of regulators on vegetative growth, fruit quality and yield in strawberry cv. Chandler. Researchers have shown that 50 and 75 ppm GA_3 application increases fruit diameter and length more than 100 ppm GA_3 application. Fruit diameter and length were measured as 20.33 mm and 29.35 mm in the control group. While 27,25 mm diameter and 37,25 mm length were determined in 50 ppm gibberellic acid application, 24.44 mm diameter and 35.87 mm length were determined in 100 ppm gibberellic acid application. Similarly, Jamal Uddin et al. (2012) also applied 50, 75 and 100 ppm gibberellic acid and they reported that there was an increase in fruit size at each dose. However, this increase was more at doses of 50 and 75 ppm application than at 100 ppm dose application. Dimensions of 21.8 and 28.3 mm in the control group were determined as 25 and 32.7 mm at 75 ppm and as 23.6 and 28.8 mm at 100 ppm. These findings are consistent with our work in terms of implementation but It is seen that there is a numerical difference arising from the varietal difference.

With the increase in application dose, harder fruits occurred and the hardest fruit (1.37 kg/cm^2) was obtained with 100 ppm application. When firmness was 1.31 kg/cm^2 in the fruits not treated with gibberellic acid, the softest fruits were recorded as 1.07 kg/cm^2 in 50 ppm GA_3 applied fruits (Table 2). In the different studies have indicated that firmness increases with GA_3 application. It is expressed that the application of 100, 200, and 300 ppm GA_3 to peach plants enhances the fruit firmness (Çetinbaş 2010). In the study on apples was determined that with GA_3 application (6.4 kg/cm^2), fruit firmness were less than control (6.8 kg/cm^2) (Atay 2013). In strawberries, the effect of gibberellic acid was investigated in two different varieties and the differences occurred in the cultivars. While Sweet Charlie is harder with 10 ppm gibberellic acid application than in control, in the Camarosa variety, the control group fruits were harder than the 10 ppm application (Özdemir et al. 2013). The difference between the findings is thought to be due to the fact that the fruit firmness varies with the varieties and application doses. Because in our study, there was a decrease in hardness at low dose, but the hardness increased at high dose.

Table 2. Effect of GA_3 on firmness (kg/cm^2), SSC (brix°), pH and TA (%) of strawberry cv Seascape

Treatment	Firmness (kg/cm^2)	SSC (brix°)	pH	TA (%)
0 ppm	1.29 a*	6.65 a	4.11 a	1.09 a
50 ppm	1.07 a	6.59 a	3.88 b	1.11 a
100 ppm	1.31 a	6.67 a	4.09 a	0.98 a

*There are significant differences ($p<0.05$) between means indicated same later in same column

While the amount of soluble solid content increased with increasing application dose, this value reduced with the application of low doses of gibberellic acid. The highest value was obtained from the application of 100 ppm gibberellic acid (6.67 brix°) while the lowest value was obtained from the apples of 50 ppm (6.59 brix°) (Table 2). Kumar et al. (2013) indicated that GA_3 (7.56 brix°) at 50 ppm doses had a higher SSC value than 100 and 150 ppm doses. In another study, 50, 75, and 100 ppm doses applications increased TSS levels and the highest increase was in the 100-ppm dose application (4.8 brix°) (Jamal Uddin et al. 2012). Although our study was in harmony with Jamal Uddin and his colleagues, it is thought that the difference between the other studies is due to the application and variety.

pH of fruit decreased with application of gibberellic acid. pH value of 4.11 in the highest control group fruits was recorded as 3.88 in the lowest 50 ppm gibberellic acid application (Table 2). It has been reported that the amount of pH is increased by application of gibberellic acid in cherry fruits (Pehluvan et al. 2012). Kumar et al. (2013) determined the highest pH value as 3.87 in 50 ppm dose application in the study of strawberries applying 50, 100 and 150 ppm GA_3. In our study, pH value decreased with application. The difference is thought to be due to ecological factors and variety.

There was a difference between applications in terms of titratable acidity value. While the increase occurred in TA with 50 ppm gibberellic acid application (1.11 %), the decline occurred with 100 ppm gibberellic acid application (% 0.98) in this value. In the control group, TA was found to be 1.09% (Table 2). Sharma and Singh (2009) obtained more titratable acidity (0.77 %) than control (0.88 %) in the strawberry fruits that applied GA_3 at 75 ppm in February. Kumar et al. (2013) reported that 50, 100 and 150 ppm treatments did not have a favorable effect on titratable acidity and the highest values were obtained from control fruits (0.79 %). According to Özdemir et al. (2013), while the value of TA increased in Sweet Charlie variety, it decreased in Camarosa variety with the application of GA_3. It is thought that the difference between the findings is due to the variety, application form and ecological factors.

Table 3. Effect of GA_3 on taste, aroma and juiciness of strawberry cv Seascape (1-5)

Treatment	Taste	Aroma	Juiciness
0 ppm	4	4	3
50 ppm	4	3	3
100 ppm	4	3	3

Gibberellic acid treatment affected the aroma value of fruits when they did not affect the juiciness and taste value of the fruits. When the taste was determined as good, the juiciness was moderate. The amount of aroma was higher in the control group and decreased with application. The aroma, which is good in the control group, was moderately determined in both doses of gibberellic acid. According to a study of strawberry cv. Camarosa, taste and aroma decreased with low doses of gibberellic acid but they increased with high doses (Roussos et al. 2009). According to Saima et al. (2014), the amount of juice is increased by application of gibberellic acid. Plants treated with GA_3 at a 100-ppm dose had 10 % more fruit juice than control group fruits. In another study, the amount of juice determined as 71 % in the control group was reported as 74 % with 75 ppm dose (Sharma and Singh, 2009). There is a difference in strain and variety in the studies done. Moreover, the increase is numerically less and the difference is thought to be due to the method. In the study was determined that gibberellic acid application variety influences the fruit quality of Seascape. In general, the application of 50 ppm dose increased the fruit quality more.

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