ÇOMÜ Zir. Fak. Derg. (COMU J. Agric. Fac.)
Yıl: 11 (2): 239-245
ISSN: 2147–8384 / e-ISSN: 2564–6826
doi: 10.33202/comuagri.1291994

Research Article

The Effects of Gibberellic Acid and Cane Girdling of Applications on Crimson Seedless Grape Variety of Cluster and Berry Characteristics

Harun Çoban[1*]

[1]Canakkale Onsekiz Mart University, Faculty of Agriculture Department of Horticulture 17100Çanakkale/Türkiye
*Corresponding author: harun.coban@comu.edu.tr

Received Date: 03.05.2023 Accepted Date: 05.10.2023

Abstract

'Crimson Seedless' grape variety is a late maturity and small berry size. Berry size is one of the most important quality parameters of table grapes. This trial was carried out in the Crimson Seedless (*Vitis vinifera L.*) grower vineyard in Sarıgöl (dadağlı) locality of Manisa province in the 2022 vegetation period. A randomized complete block design was used with vines as blocks and clusters as the experimental unit's four treatments and four replications. Vine bunches of Crimson Seedless grape variety, ten years old, were sprayed extensively with a GA_3 (Gibberellic Acid) solution (20 mg L^{-1}) on the 25th of April 10th of May, and 10th of June/2022, while girdling (G) was applied from removing 3 mm diameter bark all around from 10 cm below the top of the vine trunk at fruit set stage. Control (C) only water was sprayed. This study aimed to reveal gibberellic acid and cane girdling applications on Crimson Seedless cluster and berry characteristics. Harvest (^{o}Brix 19) was done on the 10th of October/2022 and after that, the cluster weight (g), cluster length (cm), cluster width (cm), berry weight (g), berry length (mm), berry diameter (mm), berry length/berry diameter, total soluble solid, total acidity and maturity index were determined in fresh fruit samples randomly taken from each vine. It was found that all applications generally had statistically ($P<0.05$) significant effects on grape cluster weight, cluster length, cluster width, berry weight, berry length (BL), berry diameter BD), BL/BD, total soluble solid, total acidity, and maturity index in Crimson Seedless variety.

As a result of this study, general recommendations are made of GA_3+G, and G as the most suitable applications for growing the Crimson Seedless table grape variety.

Keywords: Crimson Seedless, girdling, GA_3, grapevine

Gibberellik Asit ve Bilezik Alma Uygulamalarının Crimson Seedless Üzüm çeşidinin Salkım ve Tane Özellikleri Üzerine Etkileri

Öz

'Crimson Seedless' üzüm çeşidi, geç olgunlaşan ve küçük taneli bir üzüm çeşididir. Tane iriliği sofralık üzümlerin en önemli kalite parametrelerinden biridir. Bu çalışmanın amacı, Gibberellik Asit (GA_3) ve Bilezik Alma (BA) uygulamalarının Crimson Seedless üzüm çeşidinin salkım ve tane özellikleri üzerindeki etkisini ortaya koymaktır. Bu deneme 2022 vejetasyon sezonunda Manisa ili Sarıgöl (dadağlı) mevkiinde Crimson Seedless (*Vitis vinifera L.*) üretici bağında yürütülmüştür. Deneme tesadüf blokları desenine göre 4 uygulama ve 4 tekerrürlü olarak düzenlenmiştir. On yaşındaki Crimson Seedless üzüm çeşidinin somaklarına 25 Nisan, 10 Mayıs ve 10 Haziran/2022 tarihlerinde GA_3 (Gibberellik Asit) çözeltisinden (20 mg L^{-1}) yoğun bir şekilde püskürtülmüştür. Bilezik alma (BA) tane tutum döneminde gövdenin üst kısmından yapılmıştır. Hasat (19 ^{o}Brix) 10 Ekim 2022 tarihinde yapılmıştır. Salkım ağırlığı (g), salkım uzunluğu (cm), salkım genişliği (cm), tane ağırlığı (g), tane uzunluğu (mm), tane çapı (mm), tane uzunluğu/tane çapı, suda çözünebilir kuru madde, toplam asitlik ve olgunluk indeksi rastgele alınan örneklerde belirlenmiştir. Tüm uygulamaların genel olarak Crimson Seedless üzüm çeşidinin salkımı ağırlığı, salkım uzunluğu, salkım genişliği, tane ağırlığı, tane uzunluğu (TU), tane çapı (TÇ), TU/TÇ, toplam çözünebilir kuru madde, toplam asitlik ve olgunlaşma indeksi üzerinde istatistiksel olarak ($P<0.05$) önemli etkilere sahip olduğu tespit edilmiştir.

Bu araştırmanın sonuçları olarak sofralık Crimson Seedless üzüm çeşidi yetiştiriciliği için genel olarak en iyi sonuç veren uygulamalar GA_3+Bilezik Alma kombinasyonu ve Bilezik Alma şeklinde önerilebilir.

Anahtar Kelimeler: Crimson Seedless, bilezik alma, GA_3, asma

Introduction

Viticulture is one of the most important agricultural activities in both hemispheres of the world. The most important reason for this is that grapes have the chance to be utilized in multiple ways such as table, drying, and must-wine production. According to 2022 data, 4,145.450 tons of the 78,234.000 tons of grapes produced in the world are produced in our country. Türkiye ranks 6th in the world grape production with a share of 5.34%. Grape production in Türkiye is realized in an area of 400.778 ha. With 5.65% of the world's grape production area, Türkiye is 5th in the world in terms of grape production area. Manisa ranks first in Türkiye with 28% of the total vineyard area and 45% of the grape production, and Sarıgöl is the most important district in table grape production and exports. Sarıgöl has 11.590 hectares of vineyard area and produces 125,415 tons of fresh grapes (Anonymous, 2022a). In general, Sultana Seedless, Red Globe, Mevlana, Superior Seedless, Trakya Ilkeren, and Antep Karası varieties are dominant in the region, and the cultivation of the Crimson Seedless grape variety has been increasing rapidly in recent years.

The Crimson Seedless grape variety (*Vitis vinifera* L.) is a small, oval grape variety with a red, crisp, and berry grain color that ripens in mid-October. If the climate is favorable, the clusters can remain on the vine until mid-November. On the other hand, not getting large enough of berry size of the variety in our region and the problem of marketing and gradual harvesting due to the coloration problem pose a problem. Much research has been conducted to increase the berry size and coloration of the Crimson Seedless grape variety (Dokoozlian et al., 1994; Dokoozlian et al., 1995; Conte et al., 2010; Kök and Bal).

Berry size is the main quality factor in international markets, farmers often overuse the growth regulators Gibberellic acid (GA_3) and forchlorfenuron (CPPU), to increase berry size (Peppi, and Fidelibus, 2008; Zoffoli et al., 2009; Abu-Zehra, 2010; Abd-el- Razek, et al., 2010; Strydom, 2013). GA_3 has been routinely used for seedless grape production to increase berry and bunch weight (Lu et al., 1995). In addition, table grapes production includes the use of GA_3 sprays at anthesis which reduces the number of flowers that set, and then an after GA_3 spray shortly thereafter which will increase berry size (Roper and Williams, 1989).

Girdling which consists of removing a small section of phloem (about 4 mm in width) from around the trunk, has been practiced for years, to produce large berries of seedless grapes intended for table use, or to enhance fruit maturity by enhancing berry coloration or accumulation of sugar (Jensen et al., 1981; Roper and Williams, 1989; Williams and Ayars, 2005; Yamane and Shibayama, 2006; Abu-Zahra, 2010; Abu-Zahra and Naseri, 2012). Girdling grapevines resulted in both an increase in carbohydrate concentration above the girdle and an increase in weight per unit leaf area (During, 1978; İşci and Altındişli, 2014; Soltekin et al., 2015). Otherwise, root carbohydrate concentrations were less for the girdled vines when compared to the control vines (Roper and Williams, 1989). Clusters treated with growth regulators mainly GA_3 at berry set (applied two weeks after anthesis) developed larger berries than the control; however, girdling resulted in the development of larger berries than the application of the growth regulator (Weaver and Winkler, 1951; Williams and Ayars, 2005; Avenant and Avenant, 2006; Abu-Zahra, 2010). Girdling and GA_3 sprays are used together shortly after anthesis as they have a synergistic effect on increasing berry size (Harrell and Williams, 1987; Ezzahovani et al., 1985; Uzun and Ceyhan, 1995; Brar et al., 2008; Zoffoli et al., 2009). Also, girdling in combination with an application of GA_3 indicates that GA_3 may mitigate the depressing effect of girdling on stomatal conductance, and subsequently whole vine water use.

This work aimed to determine the effects of cane girdling with 20 (mg L^{-1}) Gibberellic acid (GA_3) applied to improve the Crimson seedless grape's cluster and berry quality properties.

Materials and Methods

This experiment was carried out in the 2022 season at the grapevine of Crimson seedless (*Vitis vinifera* L) in Sarıgöl (dadağlı) location, Manisa. The climate in this region is semi-arid with hot dry summers and cold rainy winters. The average yearly temperature is 18.1 ^{0}C and the total amount of annual rainfall is about 643 mm (Anonymous, 2022b). Crimson Seedless is highly vigorous when planted on its roots, 10 years old. The planting distances were 3.2 m between the rows and 2.0 m on the rows and trained onto a T-trellis system. A drip irrigation system was used, and the soil structure of these vineyards is the loamy alluvial soil, and the routine cultural processing such as soil

management, and fertilizers. The number of clusters per vine was adjusted to 30. The trial design has done four treatments:

1. Control.
2. GA_3 20 mg L^{-1} (time-A: 25th of April and 10th of May, spraying).
3. Girdling (G) (time-B: at fruit set stage, Phase 27), (removing 3 mm diameter bark all around from near the top of the vine trunk).
4. GA_3 + Girdling (time: A+B).

Harvest was done on the 10th of October/2022 (TSS, 19 °Brix), every five clusters per replicate were collected in paper bags and samples were immediately brought to the laboratory for analysis. After that, the cluster weight (g), cluster length (cm), cluster width (cm), berry weight (g), berry length (mm), berry diameter (mm), berry length/berry diameter were determined in fresh fruit samples randomly taken from each vine.

The percentage of total soluble solids (TSS %) was measured by the Refractometer and total titratable acidity (TA %) was determined by titrating the berry juice with 0.133 N NaOH (Weaver and Winker, 1951). In addition, the maturity index TSS/TA was calculated.

A randomized complete-block design was used with vines as blocks and clusters as experimental units four treatments and four replications.

Statistical analysis, Analysis of variance (ANOVA), and Mean separation were conducted by the Least Significant Difference (LSD) using the SAS program. Differences with a probability value equal to 0.05 were considered significant.

Results and Discussion

The Effect of GA_3, G, and GA_3 + G applications on cluster characters

The Crimson Seedless grape variety was harvested on October 10, 2022. As a result of the evaluation of the data obtained, it was determined that the treatments had significantly different effects on cluster weight, cluster length, and cluster width (Table 1).

Table 1. Effect of gibberellic acid, Girdling, and gibberellic acid + girdling combination applications to cluster characters

Treatments	Cluster weight (g)	Cluster length (cm)	Cluster width (cm)
Control	755.50 d	24.10 c	13.80 c
GA_3	870.40 c	28.30 b	14.60 bc
G	910.20 b	25.00 c	15.40 b
GA_3 + G	950.00 a	29.30 a	19.10 a
$LSD_{0.05}$	9.405	2.35	1.20

a-d: Mean values followed by the same letter in each column are not significantly different (P>0.05)

Cluster weight: In terms of data on cluster weight analyzed, the highest value was observed in GA_3 + G treatment with 950 g while the lowest value was obtained from control vines with 755.5 g. The other treatments were between these two values in the following order: G, 870.4 g; GA_3, 706 g (Table 1). In other words, GA_3 treatments increased cluster weight by 15.16 %, Girdling treatment increased it by 20.52 % and GA_3+G treatment increased it by 25.82 % compared to control.

These results support the view expressed by Brown et al. (1988), Zabadal (1992), and Camcı and Çoban (2016) that cultural practices have a positive effect on fresh grape Clusters.

Cluster length: As a result of the evaluation of the data on cluster length, the highest value was observed in GA_3 + G treatment at 29.30 cm while the lowest value was observed in control vines at 24.10 cm (Table 1). The results of other treatments were between these two values (GA_3, 28.30 cm; G, 25.00 cm). When the values obtained are calculated in percentages GA_3 treatments increased cluster length by 17.42 %. Girdling treatment increased it by 3.73 % and GA_3+G treatment increased it by 21.57 % compared to the control. These results are in agreement with the opinion of Bahar et al.,

(1998), Brown et al. (1988), and Camcı and Çoban (2016) that the related treatments had positive effects on cluster length.

Cluster width: In cluster width, the highest value was obtained from GA_3 + G with 19.10 cm and the lowest value was obtained from Control with 13.80 g. The other treatments were between these two values in the following order: G, 15.40 cm; GA_3, 14.60 cm (Table 1). GA_3 treatments increased cluster width by 11.45 %, Girdling treatment increased it by 17.55 % and GA_3+G treatment increased it by 45.80 % compared to control. These findings are in parallel with the results of Dokoozlian et al. (1995), Camcı and Çoban (2016) on Round Seedless and İşci and Altındişli (2014) on Trakya İlkeren grape varieties, which showed that trunk girdling treatments increased cluster width compared to control vines.

The Effect of GA_3, G, and GA_3 + G applications on berry characters.

The effect Control of GA_3, G, and GA_3 + G treatments on berry weight, berry length, berry diameter, and berry length/berry diameter were found to be statistically significant, and they formed different groups (Table 2).

Berry weight: In terms of berry weight, while the highest values are obtained from GA_3 + G (7.5 g, a group), the lowest values were found in the control berry (5.7 g, c group). All treatments (GA_3, G, and GA_3 + G) improved berry weight compared to naturally treated berries. Also, GA_3 treatments increased berry weight by 14.03 %, Girdling treatment increased it by 17.54 % and GA_3+G treatment increased it by 31.57 % compared to control. These results coincide with that obtained by Dokoozlian et al., (1995), Lu et al., (1995), Abu-Zehra (2010), and Gözcü and Dardeniz (2022), in which GA_3, G, and GA_3 + G have been routinely used for seedless grape production to increase berry weight.

Berry length: As a result of the evaluation of the data on berry length, the highest value was observed in GA_3 + G treatment with (27.4 mm, a group) while the lowest value was observed in control vines with (23.3 mm; c group (Table 2). The results of other treatments were between these two values (GA_3, 24.7 mm, bc group; G, 25.2 mm, ab group). In addition, GA_3 treatments increased berry length by 6.08 %, Girdling treatment increased it by 8.15 % and GA_3+G treatment increased it by 17.5 % compared to control. These findings are in parallel with the results of Roper and Williams (1989), Williams and Ayars (2005), and Zhenming et al., (2008). Also, girdling and GA_3 sprays are used together shortly after anthesis as they have a synergistic effect on increasing berry size (Dokoozlian et al., 1995; Brar et al., 2008; Harrell and Williams, 1987; Abu-Zehra, 2010; Camcı and Çoban, 2016; Gözcü and Dardeniz, 2022).

Table 2. Effect of gibberellic acid, Girdling, and gibberellic acid + girdling combination applications to berry characters

.**Treatments**	**Berry weight (g)**	**Berry length (BL) (mm)**	**Berry diameter (BD) (mm)**	**BL/BD**
Control	5.72 c	23.31 c	17.32c	1.35 b
GA_3	6.58 b	24.74 bc	19.61 b	1.26 c
G	6.71b	25.23 ab	19.24ab	1.31 d
GA_3 + G	7.52 a	27.41 a	20.2 2a	1.36 a
$LSD_{0.05}$	0.23	1,56	0.561	0.023

a-d: Mean values followed by the same letter in each column are not significantly different (P>0.05)

Berry diameter: The same results were obtained as in berry weight and diameter (Table 2). While the highest berry diameter was obtained by the GA_3 + G (20.2 mm, a group) and GA_3 (19.6 mm, b group) treatments, the lowest values were found in the control berry diameter (17.3 mm, c group). In other words, GA_3 treatments increased berry diameter by 13.23 %, Girdling treatment increased it by 10.98 % and GA_3+G treatment increased it by 16,76 % compared to the control. Similar results were obtained by Roper and Williams (1989); the use of GA_3 at anthesis increased berry size due to the increase in sink strength for accumulating nutrients such as K (Zhenming et al., 2008; Abu-Zehra, 2010). Moreover, girdling grapevines increases carbohydrate concentration above the girdle, resulting

in larger berries as the transport of sugars from leaves to the root system is effectively blocked (Roper and Williams, 1989).

Berry length/ Berry diameter: group each application formed a different group. The highest value was observed in GA_3 + BA treatment with (1.36, a group) while the lowest value was determined in GA_3 with (1.26, c group) (Table 2). The results of other treatments have occurred between these two values (Control, 1.35, b group; G, 1.31, d group). Additionally, GA_3 treatments decreased BL/BD by -6.66 %, Girdling treatment decreased it by -2.96 % and GA_3+G treatment increased it by 0.74 % compared to control.

Effect of GA_3, G, and GA_3 + G treatments on pH, TSS, TA, and maturity index.

The effect Control of GA_3, G, and GA_3 + G treatments on pH, TSS, TA, and maturity index (TSS/TA) were found to be statistically significant, and they formed different groups. It was only found to be statistically insignificant in terms of pH (Table 3).

Total soluble solids: While all applications were in the same group with very close values, the control formed another group (Table 3). In other words, GA_3 treatments increased TSS by 0.5 %, Girdling treatment increased it by 2.57 % and GA_3+G treatment increased it by 1.54 % compared to the control. Similar results were obtained in the studies conducted by Dokozolian et al., (1995). However, by Abu-Zehra et al., (2012) obtained different results in their study. This may be due to the different grape varieties and geographical locations used in the research.

Total Acidity: In terms of Acidity, the highest values are obtained from the control. Acidity values decreased in all applications (Table 3). In addition, GA_3 treatments decreased TA by – 1.81 %, Girdling treatment decreased it by -3.63 % and GA_3+G treatment decreased it by -5.45 % compared to control. Thes These results are consistent with previous research (Dokoozlian et al., 1995; Abu-Zehra, 2010; Abu-Zehra et al., 2012).

Table 3. Effect of GA_3, Girdling, and GA_3 + Girdling treatments on pH, TSS, TA, and maturity index.

Treatments	pH	TSS (ºBrix)	TA (%)	maturity index (TSS/TA)
Control	3.74	19.40 ab	0.55 a	35.27 b
GA_3	3,65	19.51 a	0.54 b	36.11 b
G	3.73	19.94 a	0.53 c	37.55'a
GA_3 + G	3.63	19.73'a	0.52 d	37.89'a
$LSD_{0.05}$	NS	0.37	0.045	1.23

a-c: Mean values followed by the same letter in each column are not significantly different (P<0.05).
NS: Not Significantly.

Maturity index: As a result of the evaluation of the data on maturity index, the highest values were observed in GA_3 + G and G treatment with (37.88 and 37.54, a group) while the lowest value was determined in control and GA_3 vines with (35.27 and 36.11, b group) (Table 3). When the values obtained are calculated in percentages GA_3 treatments increased the maturity index by 2.55 %. Girdling treatment increased it by 6.53 % and GA_3+G treatment increased it by 7.38 % compared to the control.

Conclusion

In Sarıgöl/Manisa province, the production area of the Crimson Seedless grape variety, which is a late maturity seedless colored, and small berry size grape variety has been increasing day by day in recent years. This variety, which entered the table grape market in the late period in the region, provides high income when evaluated for table purposes. To improve cluster and berry characteristics of this variety, GA_3, Girdling, and GA_3 girdling treatments were applied.

The results of the research can be summarized as follows.

1. Treatments had different effects on cluster weight, cluster length, and cluster width. Accordingly, GA_3 treatments increased cluster weight by 15.16 %, G treatment increased it by 20.52 % and GA_3+G treatment increased it by 25.82 % compared to control.

2. Treatments increased the berry characteristics in the Crimson Seedless grape variety.
3. All treatments increased TSS matter compared to control while decreased TA matter compared to control.
4. Treatments had no effect as statistical on pH.

According to these findings, it can be suggested that GA_3+Girdling and Girdling are the most suitable practices for growing table grapes (for Crimson Seedless) with high quality and commercial value.

Authors' Contributions

The authors declare that they have contributed equally to the article.

Conflicts of Interest Statement

The authors declare that they have no conflict of interest.

References

Abd El-Razek, E., Treutter, D., Saleh, M.M., El-Shammaa, M., Fouad, A., Abdel-Hamid, N., Abou-Rawasch, M., 2010. Effect of defoliation and fruit thinning quality of Crimson seedless grape. Res. J. Agric. Biol. Sci. 6:289-295.

Abu-Zahra, T.R., Naseri. M., 2012. Influence of gibberellic acid and cane girdling on berry size of Black Magic grape cultivar. Middle East Journal of Scientific Research. 11 (6):718-722.

Abu-Zahra, T.R., 2010. Berry size of Thompson seedless as influenced by the application of gibberellic acid and cane girdling. Pak. J. Bot. 42:1755-1760.

Amerine, M.A, Creuess, W.V., 1960. The Technology of Wine Making. Avi. Publishing Co. Westport, Connecticut. pp 84-88.

Anonymous, 2022a. http://www.tuik.gov.tr/PreTablo.do?alt_id=1001 (10 April 2023).

Anonymous, 2022b.https://www.mgm.gov.tr/ veridegerlendirme / il- ve – ilceler - istatistik. Aspx ? m = Sarıgöl (4 April 2023).

Avenant, J.H., Avenant, E., 2006. Effect of gibberellic acid and CPPU on color and berry size of 'Redglobe' Grapes two on two soil types. Acta Hort. 727:371-379.

Bahar, E., Çelik, S., Korkutal, D.İ., Çevik, İ., Ciciler, Ö., 1998. The effect of girdling on berry and cluster quality on 'Tekirdağ Çekirdeksizi' grape variety. Yalova, 4th Viticulture Symposium (20-23 October,) pp 372-376.

Brar, H.S., Singh, Z., Swinny, E., Cameron, I., 2008. Girdling and grapevine leaf-associated roll-associated viruses affect berry weight, colour development, and accumulation of anthocyanins in 'Crimson Seedless grapes during maturation and ripening. Plant Science. 175:885-897.

Brown, K., Jackson, D.I., Steans, G.F., 1988. Effects of Claremont, girdling, and tipping on berry set in *Vitis vinifera* L. Am. J. Enol. Viticulture. 39 (1):91-94.

Camcı, H., Çoban, H., 2016. The Effect of Applications GA3, Cluster Tipping and Girdling on Yield and Quality in Superior Seedless (*Vitis vinifera L.*) Grape Variety. Journal of Ege Univ. Agric. Fac. 53(3):351-358.

Conte, A., Mastromatteo, M., Antonacci, D.M., Del Nobile, M.A., 2010. Influence of cultural practices and packaging materials on table grape quality. Journal of Food Process Engineering. 35:701-707.

Dokoozlian, N., Luvisi, D., Moriyama, M., Schrader, P., 1995. Cultural practices improve colour size of 'Crimson Seedless'. California Agriculture. 49 (2):36-40.

Dokoozlian, N., Luvisi, D., Schrader, P., Moriyama, M., 1994. Influence of trunk girdle timing and ethephon on the quality of Crimson Seedless table grapes. International Symposium on Table Grapes Production, Anaheim (June 28-29), pp 237-240.

During, H., 1978. Studies on environmentally controlled stomatal transpiration in grapevines. II. Effects of girdling and temperatures. Vitis, 17:1-9.

Ezzahovani, A., Lasheen, A.M., Walali, L., 1985. Effects of gibberellic acid and girdling on 'Thompson Seedless' and 'Ruby Seedless' table grapes in Morocco. Hort-science. 20 (3):393-394.

Gözcü, Ü., Dardeniz, A., 2022. Effects of Different Girdling Applications on Grape Yield and Quality in Yalova Cekirdeksizi Grape Varieties. ÇOMÜ J. Agric Fac. 3 (5):49-57.

Harrell, D.C., Williams, L.E., 1987. The Influence of Girdling and Gibberellic acid application at fruit set on ruby seedless and Thompson seedless grapes. American Journal of Enology and Viticulture. 38(2):83-88.

İşci, B., Altındişli, A., 2014. Effect of Some Cultural Applications on Yield and Quality of Organic Table Grapes (*Vitis vinifera L.)* cv. Alphonse Lavalleé and Trakya İlkeren, Journal of Agricultural Faculty of Gaziosmanpasa University, 31 (3), 91-100.

Jensan, F., Andris, H., Beede, R., 1981. A Comparison of normal girdles and knife line girdles on Thompson Seedless and Cardinal grapes. Am. J. Enol. Vitic., 32 (3): 206-207.

Kök, D., Bal, E.2016. Seedless Berry Growth and Bioactive Compounds of cv. 'Recel Uzümü' (V. Vinifera L.) as Affected by Application Doses and Times of Pre-Harvest Thidiazuron, Erwerbs-Obstbau 58 (4), 253-258,

Lu, J., Lamikanra, O., Leong, S., 1995. Effects of Gibberellic acid on muscadine grape production. Proc. Fla. State Hort. Soc. 108:360-361.

Odabaş, F., Beyhan, N., Çelik, H., 2007. The effect of GA3 and CCC on ovule and seed development in Kabuğutufka (*Vitis vinifera* L.), International Journal of Agricultural Research. 2 (2):145:151.

Peppi, M.C., Fidelibus, M.W., 2008. Effects of forchlorfenuron and abscisic acid on the quality of Flame Seedless grapes. HortSci. 43, 173-176.

Rather, J. A., Wani, S. H., Haribhushan, A., Bhat, Z. A., 2011. Influence of girdling, thinning, and GA_3 on fruit quality and shelf life of grape (Vitis *vinifera*) cv. Perlette. Elixir Agriculture. 41: 5731-5735.

Roper, T. R., Williams, L.E., 1989. Net CO2 assimilation and carbohydrate partitioning of grapevine leaves in response to trunk girdling and gibberellic acid application. Plant Physiology. 89 (4): 1136-1140.

Shulman, Y., Nır, G., Bazak, H. Lavee, S., 1986. Grapevine girdling by morphactin oil. Hort-science. 21 (4): 999-1000.

Soltekin, O., Teker, T.,Erdem, A., Kaçar, E., Altındişli, A., 2015. Response of Red Globe (*Vitis vinifera L.*) to cane girdling, 38th World Congress of Vine and Wine, (July 5–10), - Mainz, Germany 5, 01019 p

Strydom, J., 2013. Effect of CPPU(N-(2-Chloro-4-Pyridinyl)-N'-Phenylurea) and a Seaweed Extract on Flame Seedless, Redglobe and Crimson Seedless Grape Quality. S. Afr. J. Enol. Viticulture. 34(2):233-241.

Uzun, İ., Ceyhan, E., 1995. Studies on the Effect of Gibberellic Acid and Girdling Applications on Cluster and Berry Characteristics of Yuvarlak Çekirdeksiz Grape Cultivar. Akdeniz University Journal of the Faculty of Agriculture. 8 (1):52-64.

Weaver, R.J., Pool, R.M., 1972. Effect of time of thinning on berry size of girdled, Gibberellin treated Thompson Seedless Grape. Vitis. 12:97-99.

Weaver, R.J., Winkler, A.J., 1951. Increasing the size of Thompson seedless grapes by means of 4-chlorophenoxyacetic acid, Berry thinning, and girdling. Plant Physiology. 27(3):626-630.

Williams, L.E., Ayars, J.E., 2005. Water use of Thompson seedless grapevines as affected by the application of Gibberellic acid (GA_3) and trunk girdling. Practices to Increase Berry Size. Agriculture and Forest Meteorology. 129:85-94.

Yamane, T., Shibayama, K., 2006. Effects of trunk girdling and crop load levels on fruit quality and root elongation in 'Aki Queen' Grapevines, J. Japan. Soc. Hort. Sci. 75 (6):439–444.

Zabadal, T. J., 1992. Response to 'Himrod' grapevines to cane girdling. Hort-science. 27 (9):975-976.

Zhenming, N., Xuefeng, X., Yi., Tianzhong, W.L., Jin, K., Zhenhai, H., 2008. Effects of leaf applied potassium, Gibberellin and Source-Sink Ratio on potassium absorption and distribution in grapefruits. Scientia Horticulture. 115:164-167.

Zoffoli, J. P., Latorre, B. A., Naranjo, P., 2009. Preharvest applications of growth regulators and their effect on postharvest quality of Table Grapes during cold storage. Postharvest Biology and Technology. 51(2):183-192.