

Influence of Gibberellic Acid and Cane Girdling on Berry Size of Black Magic Grape Cultivar

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Abstract: Small fruit sizing from the Black Magic grapevine were produced during the last several years, even though different cultural practices have been developed to optimize the quality of the table grapes. The influence of GA₃ application on fruit quality and productivity of cane pruned Black Magic grape cultivar as well as cane Girdling practice were evaluated. Berries treated with GA₃ or with GA₃+ Girdle developed heavier berries, increased berry diameter, produced heavier bunches and increased number of berries per bunch in compares to the control grapevine trees. Percentages of berry shattering was increased in all grapevine treatments, otherwise, berry quality was improved by GA₃; since soluble solids was increased and titratable acidity was decreased, but also GA₃ reduced berry color. GA₃ is an effective method in improving Black Magic grape cultivar berries, which could be used in wide range orchards, since; in most cases, it produced better results than girdle treated bunches and do not show any significant results than the GA₃ + Girdle treated grapevine trees.

Key words: *Vitis vinifera* • Grape: GA₃ • Girdling • Quality

INTRODUCTION

Grapevines (*Vitis vinifera* L.) are planted throughout the world to be used as dried fruits (raisins), grapes for the fresh market (table grapes) and juice for concentrate [1]. Natural berry size (about 1.5 g) of this cultivar is not large enough for commercial as table grapes, so cultural practices are used to increase its size several fold, up to 10 g berries have been found in some vineyards [2].

Berry size is the main quality factor in international markets, farmers often overuses the growth regulators; Gibberellic acid (GA₃) and forchlorfenuron (CPPU), in an effort to increase berry size [3] and GA₃ has been routinely used for seedless grape production to increase berry and bunch weight and cause thinning of clusters [4]. Cultural practices used for table grape production include the use of GA₃ sprays at anthesis which reduces the number of flowers that set and then an additional GA₃ spray shortly thereafter which will increase berry size [5]. 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 grapes

intended for table use, or to enhance fruit maturity by enhancing berry coloration or accumulation of sugar [2, 5]. The operation, however, is expensive and occasionally results in the death of the girdled cane [6]. Root carbohydrate concentrations were less for the girdled vines when compared to the control vines [5]. Girdling grapevines resulted in both an increase in carbohydrate concentration above girdle and an increase in weight per unit leaf area [7].

Clusters treated with growth regulators mainly GA₃ at berry set (applied two weeks after anthesis) developed larger berries than did the controls; however, girdling resulted in development of larger berries than did the application of the growth regulator [6, 8, 9]. Otherwise; little benefit for the use of GA₃ since berry size was not greatly improved when GA₃ was applied [10]. GA₃ applied to clusters and/ or trunk girdling increased berry weight and vine yields significantly over the control [11], also, many times girdling and GA₃ sprays are used together shortly after anthesis as they have a synergistic effect on increasing berry size [11, 12]. Girdling in combination with an application of GA₃ indicates that GA₃

may possibly mitigate the depressing effect of girdling on stomatal conductance and subsequently whole vine water use [2].

Soluble solids of GA₃ cluster-sprayed fruit were equal to or above the control, while girdling reduced it [11]. Appositive correlation between GA application and amount of nutrients like N, P or K absorbed, which enhanced both the enlargement of Grape fruits and sink capacity of grape flusters to absorb water or nutrients, such as K [13]. A few younger clusters of vine fruits sprayed with growth regulator, showed some injury; some berries on these clusters failed to enlarge and the apical one to three inches of the clusters were dead, reduced fruit set and increased berry shattering and pedicel thickness [3, 6, 10].

Anthocyanins are responsible for the color of the red and black grape berries and their concentration in the berry skin increases during berry ripening [14]. Grape berry color development has been reported to be influenced by a number of factors such as cultivar, cultural practices, location as well as exogenous application of abscisic acid and ethephon and girdling [15]. Girdling of the grapevine has been reported to improve berry color development and to stimulate rapid ripening in grapes [16].

This study has been conducted on Black Magic grapevine orchard where small fruit sizing were produced even though during the last several years, different cultural practices have been developed to optimize the quality of the table grapes. This work was therefore designed to spray GA₃ on seeded Black Magic grapes to determine its effects on grape production and to enhance berry weight and color with girdling.

MATERIALS AND METHODS

Experimental Site: The trial was conducted during the 2009/2010 season, at Station of Princess Tasneem Bent Ghazi for Technological Research in Humrat Al-Sahen; about 15 km from As-Salt-Jordan. The climate in this region is rather hot and dry during summer, warm and rainy in winter.

GA Application, Girdling and Experimental Design: Vine bunches of Black Magic grape, 10 years old, were sprayed to runoff with a GA₃ solution (50 mgL⁻¹) at the 10th April, 28th April and 8th May/2009, while girdling which consisted of removing a strip of bark three sixteenths of an inch in width near the base of canes with girdling plies, was done at berry set stage with the girdling knife [12] at

the 10th April/2009. The experiment consisted of four treatments; natural fruit set as control (no GA₃, no Girdle), GA₃, Girdle and GA₃ + Girdle. Four replicate canes were selected at random among the vines used. Berries harvesting was done at 10th June/2009 when the berries complete there maturation (according to farmers date). Each five bunches per replicate were collected in a paper bags for analysis, samples were immediately brought to the laboratory for analysis.

Observations Recorded: The number of produced berries per harvested bunches were counted and then the average readings were considered per one bunch. 100 berries were sampled from each replication, the sampled berries from each replication were weight and average berry weight (g) was determined. Berry diameter (mm) was determined using caliper for 20 berries per replicate and then average readings were considered per one berry. Shatter potential was measured by dropping clusters from a standard height and percentage of shatter berries were recorded per one bunch (10). Berries were crushed and the percentage of total soluble solids percentage (TSS %) was determined. Total titratable acidity percentage (TTA %) was determined by diluting 10 ml of the juice to 50 ml with distilled water and titrating with 0.133 N NaOH, using phenolphthalein as an indicator. The results were expressed as grams of acid calculated as tartaric acid per 100 ml of juice, which is approximately the percentage of acid [6].

Berry color at harvest, 30 berries were randomly chosen from each replication for recording the berry skin color, which was recorded as total anthocyanin (in mg anthocyanin 100 g fruit fresh weight⁻¹). The berry color measurements were made using a spectrophotometer and average bunch color was calculated for each replication [12]. Harvested bunches per replicate were weight and the average weight (g) of one bunch was considered, also bunch elongation (cm) was measured for all of the harvested bunches and considered per one bunch.

Experimental Design and Statistical Analysis: The experiment design was a randomized complete block design (RCBD), with a single grapevine as an experimental unit with four treatments and replicated four times. The data were subjected to analysis of variance (ANOVA) [17]. The differences between means of the different treatments were compared by the Least Significant Difference (LSD) test using SAS and differences with probability value at P = 0.05 were considered significant.

RESULTS

Berry weight: Berries treated with GA₃ + Girdle developed the heaviest berries with a significant difference with all other treatments (Table 1). All treatments improved berry weight in comparison with naturally treated berries (control), which produced the lowest berry weight (2.02 g).

Berry Diameter: Berries diameter were increased with the application of all treatments compared to the naturally treated bunches (Table 1); clusters treated with GA₃, however, resulted in development of larger berries than did the application of other treatments, with a significance differences only with the control treatment, which produced the smallest berries, but without significant differences with the girdle treated berries. Also girdling grapevines increases carbohydrate concentration above girdle and resulted in larger berries as the transport of sugars from leaves to the root system is effectively blocked.

Bunch Weight: The highest bunch weight was obtained by the use of GA₃ + Girdle treatments (Table 1), but without a significant difference with the GA₃ treated bunches alone. On the other hand, the lowest bunch weight (68.51 g) was resulted from the naturally produced bunches, without significant differences from the girdle produced bunches.

Number of Berries per Bunch: Berries numbers were increased in all treatments in comparison to the control grapevine trees (Table 1). The highest berries number (40.5) was obtained by the control grapevine trees, while the lowest number [29] was obtained by the naturally treated grapevines.

Bunch Elongation: No significant differences were observed between all the used treatments (Table 2), even though; the largest bunch (19.95 cm) was obtained by the GA₃ + Girdle treatment and the shortest bunch (17.45 cm) was obtained by the control bunches.

Berry Shatter: Berry shattering was very low in all the used treatments (Table 2), despite of the increase in berry shattering percentage in all the used treatments compared to the control berries, but the use of GA₃ alone has no significant differences compared with the control grapevines, which produced the lowest berry shatter percentage (2.75 %).

Total Soluble Solids: Soluble solids percentages of GA₃ cluster-sprayed fruit were improved (Table 2), while Girdling produced berries with TSS % nearly equal to that of control.

Total Titratable Acidity: results showed that the highest TTA % was obtained by the control grapevines (Table 2), but without any significant difference with the Girdle or GA₃ + Girdle treated berries. While the highest TTA % was obtained by the GA₃ treated berries.

Table 1: Effect of GA₃ and Girdling treatments on berry weight (g), bunch weight (g), berry diameter (mm) and berry number/bunch of Black Magic grape*

Treatments	Berry wt. (g)	Berry diameter (mm)	Bunch wt (g)	Berry no./bunch
Control	2.02 c**	7.80 b	68.51 b	29.0 b
GA ₃	2.14 b	9.15 a	80.18 a	39.5 a
Girdle	2.06 bc	8.50 ab	72.08 b	36.0 ab
GA ₃ + Girdle	2.29 a	8.85 a	85.34 a	40.5 a

* Values are the mean of four replicates.

** Means within each column having different letters are significantly different according to LSD at 5 % level.

Table 2: Effect of GA₃ and Girdling treatments on bunch elongation (cm), number of berry shutter, Total soluble solids (TSS) %, total titratable acidity (TTA) % and anthocyanin content (mg/100 g f. f. wt.) of Black Magic grape*

Treatments	Bunch elongation (cm)	Berry shatter (%)	TSS (%)	TTA (%)	Anthocyanin (mg 100 g f. f. wt. ⁻¹)
Control	17.45 a **	2.75 b	10.95 bc	9.13 a	42.3 a
GA ₃	19.83 a	3.25 ab	14.86 a	8.00 b	33.5 b
Girdle	17.63 a	3.75 a	9.56 c	8.70 ab	41.3 a
GA ₃ + Girdle	19.95 a	4.00 a	12.96 ab	9.08 a	36.0 b

* Values are the mean of four replicates.

** Means within each column having different letters are significantly different according to LSD at 5 % level

Total Anthocyanin: No significant difference were found between Girdling and control in regard to the highest anthocyanin content (41.3 mg 100 g f. f. wt⁻¹ and 42.3 mg 100 g f. f. wt⁻¹ respectively). Otherwise, bunches treated with GA₃ or with GA₃ and Girdle significantly reduced the color of the fruits. The application of GA₃ is found to reduce berry color, while girdling of the grapevine has been reported to improve berry color development and stimulate rapid ripening in grapes [15, 16].

DISCUSSION

Berry Weight: Berries treated with GA₃ + Girdle developed the heaviest berries with a significant difference with all other treatments (Table 1). All treatments improved berry weight in comparison with naturally treated berries (control), which produced the lowest berry weight (2.02 g). These results coincides with that in which girdling and GA₃ sprays were used together as they have a synergistic effect on increasing berry size [12]. Also, GA₃ and girdling practiced for years, to produce and enhance large berries of grapes fruits [2, 4, 5, 13] since; girdling grapevines resulted in both an increase in carbohydrate concentration above girdle [7].

Berry Diameter: Berries diameter were increased with the application of all treatments compared to the naturally treated bunches (Table 1); clusters treated with GA₃, however, resulted in development of larger berries than did the application of other treatments, with a significance differences only with the control treatment, which produced the smallest berries, but without significant differences with the girdle treated berries. The uses of GA₃ at anthesis were found to increase berry size due to increase sink strength for accumulating nutrients, such as K [5, 13]. Also girdling grapevines increases carbohydrate concentration above girdle and resulted in larger berries as the transport of sugars from leaves to the root system is effectively blocked [5].

Bunch Weight: The highest bunch weight was obtained by the use of GA₃ + Girdle treatments (Table 1), but without a significant difference with the GA₃ treated bunches alone. On the other hand, the lowest bunch weight (68.51 g) was resulted from the naturally produced bunches, without significant differences from the girdle produced bunches. GA₃ has been routinely used for seedless grape production to increase berry and bunch weight [4].

Number of Berries per Bunch: Berries numbers were increased in all treatments in comparison to the control grapevine trees (Table 1). The highest berries number (40.5) was obtained by the control grapevine trees, while the lowest number [29] was obtained by the naturally treated grapevines. These results do not coincide with whom found that the use of GA₃ sprayed at anthesis reduced number of flowers that set [5].

Bunch Elongation: No significant differences were observed between all the used treatments (Table 2), even though; the largest bunch (19.95 cm) was obtained by the GA₃ + Girdle treatment and the shortest bunch (17.45 cm) was obtained by the control bunches. The increase in bunch weight due to use of GA₃ and/ or GA₃ + Girdle may be reflected on its length.

Berry Shatter: Berry shattering was very low in all the used treatments (Table 2), despite of the increase in berry shattering percentage in all the used treatments compared to the control berries, but the use of GA₃ alone has no significant differences compared with the control grapevines, which produced the lowest berry shatter percentage (2.75 %). Similar results were obtained by other researchers [3, 10] whom found that spraying clusters of grapevine with growth regulators showed some injury and increased berry shattering.

Total Soluble Solids: Soluble solids percentages of GA₃ cluster-sprayed fruit were improved (Table 2), while Girdling produced berries with TSS % nearly equal to that of control. These results are in agreement with other researchers whom found that soluble solids of GA₃ cluster-sprayed fruit were equal to or above the control, while Girdling reduced it [11].

Total Titratable Acidity: Results showed that the highest TTA % was obtained by the control grapevines (Table 2), but without any significant difference with the Girdle or GA₃ + Girdle treated berries. While the highest TTA % was obtained by the GA₃ treated berries.

Total Anthocyanin: The highest anthocyanin content 41.3 mg 100 g f. f. wt⁻¹ and 42.3 mg 100 g f. f. wt⁻¹ were found in Girdled and control treated bunches respectively, but without significant differences. Otherwise, bunches treated with GA₃ or with GA₃ and Girdle significantly reduced the color of the fruits, so the application of GA₃ is found to reduce berry color (16) in which girdling of the grapevine has been reported to improve berry color development and to stimulate rapid ripening in grapes.

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