Pak. J. Bot., 42(3): 1755-1760, 2010.

BERRY SIZE OF THOMPSON SEEDLESS AS INFLUENCED BY THE APPLICATION OF GIBBERELLIC ACID AND CANE GIRDLING

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Abstract

The influence of GA_3 application on the fruit quality and productivity of cane pruned Thompson seedless was evaluated. Four treatments applied were: GA_3, Girdle, GA_3 + Girdle and control with no GA_3 and no girdle were used. GA_3 or GA_3 + Girdle berries resulted in heavier berries, hastened berry diameter, and produced larger berries in comparison to the control grapevine trees. In addition, bunch weight and length were increased, while number of berries per bunch was not affected by the applied treatments. Percentage of berry shattering was increased in all grapevine treatments compared to the control treatment. On the other hand, berry quality was improved by GA_3 application as indicated by soluble solids and titratable acidity. It can be concluded that GA_3 is an effective method for improving Thompson seedless grapevine berries compared with girdle treated bunches.

Introduction

Thompson seedless grapevines (*Vitus vinifera* L.) are planted throughout the world and are used to produce dried fruits (raisins), grapes for the fresh market (table grapes) and juice for concentrate (Mullins *et al*., 1992). 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 and up to 10 g berries have been found in some vineyards (Williams & Ayars, 2005).

Berry size is the main quality factor in international markets, farmers often overuse the growth regulators were Gibberellic acid (GA_3) and forchlorfenuron (CPPU), in an effort to increase berry size (Zoffoli *et al*., 2009). GA_3 has been routinely used for seedless grape production to increase berry and bunch weight, and cause thinning of clusters (Lu *et al*., 1995). Cultural practices used for table grape production include the use of GA_3 sprays at anthesis which reduces the number of flowers that set and then an additional GA_3 spray shortly thereafter which will increase berry size (Roper & 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 Thompson seedless grapes intended for table use, or to enhance fruit maturity by enhancing berry coloration or accumulation of sugar (Roper & Williams, 1989; Williams & Ayars, 2005). The operation, however, is expensive and occasionally results in the death of the girdled cane (Weaver & Winker, 1951). Girdling grapevines resulted in both an increase in carbohydrate concentration above girdle, and an increase in weight per unit leaf area (During, 1978). Other wise, root carbohydrate concentrations were less for the girdled vines when compared to the control vines (Roper & 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 development of larger berries than the application of the growth regulator (Peacock, 1997;

Retamales *et al*., 1994; Weaver & Winker, 1951; Williams & Ayars, 2005). In another study conducted by Dokoozlian (1999) little benefit for the use of GA_3 sizing applications was found, since berry size was not greatly improved when GA_3 was Applied.

GA_3 applied to clusters and or trunk girdling increased berry weight and vine yields significantly over the control (Harrell & Williams, 1987). Girdling and GA_3 sprays are used together shortly after anthesis as they have a synergistic effect on increasing berry size (Brar *et al*., 2008; Harrell & Williams, 1987). Girdling in combination with an application of GA_3 indicates that GA_3 may possibly mitigate the depressing effect of girdling on stomatal conductance, and subsequently whole vine water use (Williams & Ayars, 2005).

Soluble solids of GA_3 cluster-sprayed fruit were equal to or above the control, while girdling reduced it (Harrell & Williams, 1987). A positive correlation between GA application and amount of nutrients (N, P and K) was found, which enhanced both the enlargement of Grape fruits and sink capacity of grape flusters to absorb water or nutrients (Zhenming *et al*., 2008). 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 (Weaver & Winker, 1951), reduced fruit set, and increased berry shattering and pedicel thickness (Dokoozlian, 1999; Zoffoli *et al*., 2009).

This study has been conducted in Thompson seedless grape orchards were different cultural practices have been developed to optimize the quality of the table grapes. This work was aimed to evaluate girdling along with 50 ppm Gibberellic acid (GA_3) applied to improve the berry size of Thompson seedless grape.

Materials and Methods

The trial was conducted during the 2008 season, at Station of Princess Tasneem Bent Ghazi for Technological Research in Humrat Al-Sahen about 25 km from As-Salt-Jordan. The climate in this region is rather hot and dry during summer, warm and rainy in winter. Vine bunches of Thompson seedless grape, 10 years old, were sprayed extensively with a GA_3 solution (50 mg/L) on 10^{th} of April, 28^{th} of April, and 8^{th} of May/2008, 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 according to Brar *at al*., (2008) on 10^{th} of April/2008. The experiment consisted of four treatments viz., natural fruit set as control (no GA_3, no girdle were used), GA_3, Girdle, and GA_3 + Girdle. Four replicate canes were selected at random among the vines used. Berries harvesting was done at 10^{th} of June/2008 when the berries completed their maturation (according to farmers date). Each five bunches per replicate were collected in a paper bags and samples were immediately brought to the laboratory for analysis.

Measured parameters: The number of produced berries per bunches at harvesting were counted. Hundred berries were taken for the measurements of berry weight (g) and berry diameter (mm) determined using Caliper. Shatter potential was measured by dropping clusters from a standard height and percentage of shattered berries per bunch was recorded (Dokoozlian, 1999). The percentage of total soluble solids (TSS %) was measured by the Refractometer and total titratable acidity (TTA %) was determined by titrating the berry juice with 0.133 *N* NaOH. The TTA% was expressed as grams of tartaric acid per 100 ml of juice (Weaver & Winker, 1951). In addition, harvested bunches were weighed and bunch elongation (cm) was measured for all the harvested bunches.

Experimental design and statistical analysis: The experimental design was a randomized complete block design (RCBD), with one grapevine tree as an experimental unit. Each treatment was replicated four times. The data were subjected to analysis of variance (ANOVA), according to procedures outlined by Steel & Torrie (1980). Mean separation was conducted by the Least Significant Difference (LSD) using SAS program. Differences with probability value equals to 0.05 were considered significant.

Results and Discussion

Berry weight: Berries treated with GA_3 + Girdle developed heavier berries without a significant difference with the GA_3 treated berries (Table 1). Berry weight was higher in girdled grapevines comparison to those of control grapevines; which produced the lowest berry weight (3.55 g), so all treatments (GA_3, Girdle, and GA_3 + Girdle) improved berry weight in compare to naturally treated berries. These results coincides with that obtained by Lu *et al*., (1995), in which GA_3 has been routinely used for seedless grape production to increase berry weight, also it was found that girdling was practiced for years to produce large berries of Thompson seedless grapes intended for table use (Roper & Williams, 1989; Williams & Ayars, 2005). Because girdling grapevines resulted in an increase in carbohydrate concentration above girdle (During, 1978), and or the use of GA_3 enhanced the enlargement of grape fruits (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 (Brar *et al*., 2008; Harrell & Williams, 1987).

Berry diameter: All the used treatments hastened berries diameter as compared to the naturally treated bunches (Table 1); clusters treated with GA_3 + Girdle, however, resulted in development of larger berries than did the application of other treatments, with a significant differences with the control treatment, which produced the smallest ones. Similar results were obtained by Roper & 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). 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 (Roper & Williams, 1989).

Bunch weight: Same results were obtained as in berry weight and diameter (Table 1), in which; the highest bunch weight were obtained by the GA_3 and or GA_3 + Girdle treatments, with a significant differences in the girdle treated bunches. On the other hand the lowest bunch weight was resulted from the naturally produced bunches. GA_3 has been routinely used for seedless grape production to increase berry and bunch weight, and cause thinning of clusters (Lu *et al*., 1995).

Number of berries per bunch: No statistical differences were observed between all the used treatments of grapevine trees in respect to berries number per bunch (Table 1), even though, the highest berry number (66.5) was obtained by the naturally treated grapevine, while the lowest number (60.5) was obtained by the girdle treated grapevines. These results nearly are in agreement with that obtained by Roper & Williams (1989), in which the use of GA_3 sprayed at anthesis reduced number of flowers that set.

Table 1. Effect of GA_3 and Girdling treatments on berry weight, bunch weight, berry diameter, and berry number/bunch of Thompson seedless grape.

Treatments	Berry wt. (g)	Berry diameter (mm)	Bunch wt (g)	Berry no./ bunch
Control	3.55 c*	10.52 b	239.7 c	66.5 a
GA_3	4.01 ab	12.38 a	274.3 a	64.5 a
Girdle	3.86 b	11.53 ab	260.6 b	60.5 a
GA_3 + Girdle	4.14 a	12.30 a	280.9 a	61.8 a
LSD	0.2788	1.4642	13.098	9.5688

* Values are mean of six replicates
Means within each column having different letters are significantly different at $p \leq 0.05$

Table 2. Effect of GA_3 and Girdling treatments on bunch elongation, number of berry shutter, total soluble solids (TSS), and total titratable acidity (TTA) of Thompson seedless grape.

Treatments	Bunch elongation (cm)	Berry shatter %	TSS %	TTA %
Control	18.75 b*	13.5 c	7.44 c	7.53 a
GA_3	25.38 a	24.0 a	10.11 a	5.60 b
Girdle	24.38 a	19.3 b	8.46 bc	6.16 b
GA_3 + Girdle	27.00 a	22.0 ab	9.09 ab	5.18 b
LSD	5.1626	3.9204	1.0828	1.1176

* Values are mean of six replicates
Means within each column having different letters, are significantly different at $p \leq 0.05$.

Bunch elongation: All the used treatments (GA_3, Girdle, and GA_3 + Girdle) hastened the bunch length in comparison to the natural treatment (Table 2), which produced the shortest bunch (18.75 cm). The increase in bunch weight due to the use of GA_3 and or GA_3 + Girdle may be also reflected on its length.

Berry shatter: Results in Table 2 showed that the use of GA_3 alone or with girdle increased berry shatter in comparison to the naturally treated grapevines, which produced the lowest berry shatter percentage (13.5 %), while girdled grapevines produced berries with an intermediate amount of shattering (19.3 %). Similar results were obtained by Dokoozlian (1999), and Zoffoli *et al*., (2009) who found that spraying clusters of grapevine with growth regulators showed an increase in berry shattering.

Total soluble solids: Soluble solids of GA_3 cluster-sprayed fruit were above the control (Table 2), while girdling produced berries with TSS % nearly equal to that of naturally produced grapevines. These results are in agreement with that obtained by Harrell & Williams (1987), who found that soluble solids of GA_3 cluster-sprayed fruit were equal to or above the control, while girdling reduced it.

Total titratable acidity: Results showed that the highest TTA % was obtained by the naturally treated grapevines (Table 2), no statistical differences were observed between all other treatments (GA_3, GA_3 + Girdle, and Girdle), so the use of these treatments hastened berries quality by decreasing there acidity.

Table 3. Correlation coefficients between measured parameters of Thompson seedless grape.

Parameters	Berry wt.	Berry diameter	Bunch wt.	Berry no./bunch	Bunch elongation	Berry shatter %	TSS %	TTA %
Berry wt.	1	0.69	0.76	-0.41	0.73	0.37	-0.64	0.41
Berry diameter		1	0.72	-0.25	0.63	0.52	-0.58	0.30
Bunch wt.			1	-0.02	0.68	0.50	-0.62	0.54
Berry no./bunch				1	-0.51	-0.33	0.18	-0.17
Bunch elongation					1	0.54	-0.57	0.38
Berry shatter %						1	-0.66	0.12
TSS %							1	-0.16
TTA %								1

Tabulated R value at $p \leq 0.05 = 0.4973$

Correlation coefficients between measured parameters: A significant positive correlation was obtained by berry weight with the berry diameter, bunch weight and bunch elongation (Table 3), while negative significant correlation was obtained with the TSS %. Berry diameter produced a significant positive correlation with the bunch weight and bunch elongation, and negative significant correlation with the TSS %.

Conclusions

It can be concluded that there is a potential benefit from GA_3 and GA_3 + Girdle treated grapevine in the commercial production of Thompson seedless grapes for its effective influence on yield of grapevine.

Acknowledgements

Special thanks to Dr. Alaeddin Tahboub and Dr. Tarek Ammari for critically reading the manuscript. We are also grateful to Agri. Eng. Omer Abu-Danoun for his help in the laboratory work, Agri. Eng. Meshref Ma'adat and Mr. Sufian Al-Hanbaly for their help in the filed.

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(Received for publication 3 March 2009)