BIOSCIENCES BIOTECHNOLOGY RESEARCH ASIA, December 2013. Vol. **10**(2), 527-531

Effect of Plant Hormones Application Methods on Fruit Quality of 'Superior Seedless' Grape

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DOI: http://dx.doi.org/10.13005/bbra/1162

(Received: 01 October 2013; accepted: 09 December 2013)

Seedless grapes enjoy great popularity among consumers, but their small size is a problem in their commercialization. This study was conducted during the period 2011-2013 in the Jordan Valley Vineyard in the Jordan. The experiment evaluated yield quality of 'Superior Seedless' grape after the application of Gibberellic acid (GA_3) and Naphthalene acetic acid (NAA). These growth regulators were applied during floweringby spraying the inflorescences or plunging them in whole at the following concentrations: 0 mg.L^{-1} GA_3 (control), 40 mg.L^{-1} GA_3 (treatment performed twice), 80 mg.L^{-1}GA_3, 40 mg.L^{-1}GA_3 + 0.2% NAA, and 0.2% NAA. Results showed that theapplied treatments had a beneficial effect on cluster and berry weight as well as on the number of berries per cluster in the grape variety 'Superior Seedless'. GA_3 and the mixture of 40 mg.L^{-1}GA_3 + 0.2% NAA were shown to have a significant effect on cluster and berry length. The applied treatments slightly affected berry width in the grape variety under study. On the other hand an adverse effect on extract content of the 'Superior Seedless' fruit were found by the use of the plant hormones.

Key words: Superior,Grape, Plant Hormones, GA_3,NAA.

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).

Berry size is the main quality factor in international markets, farmers often overuse the growth regulators; 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 (Lu *et al*., 1995). In recent years, seedless grapes enjoy great popularity among consumers, but their small size is a problem in their commercialization (Abu-Zahra, 2010). Generally, growers prefer a berry diameter of at least 2.5 cm for fresh market use (Conner, 2009).A berry size of about 1.5 g is not large enough for commercial as table grapes so cultural practices are used to increase its size several folds and up to 10 g berries have been found in some vineyards (Williams & Ayars, 2005).

Berry size is affected by many things like hormones, nutrients and environmental factors (Ollat *et al*. 2002). 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 and Williams, 1989).Berries treated with GA_3 or with GA_3+ Girdle developed heavier berries, increased berry diameter, produced heavier bunches and increased number of berries per bunch in compare to the control grapevine trees (Abu-Zahra and Salameh, 2012).Gibberellic acid affects grape berry

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by means of different ways; include formation of flower cluster, berry set, berry enlargement, cluster lengths elongation, berry thin in cluster, prevention of berry cracking (Korkutal *et al.* 2008).

Superior Seedless grape is considered the best seedless grapethat are recommended for cultivation, depending upon its productivity (My[liwiec, 2009).Accordingly, this study was conducted on this cultivar to evaluatethe method of gibberellic acid (GA_3) and Naphthalene acetic acid (NAA) application, and their effect on the fruit quality.

MATERIALS AND METHODS

This study was conducted during the period 2011-2013 in the Jordan Valley Vineyard in the Jordan.The experimental material comprisedgrape vines of the 'Superior Seedless' grapevariety which were planted in the spring of 1998(about 12 years old).The grape vines were trained to grow up at arbor trellis.

Gibberellic acid (GA_3) and Naphthalene acetic acid (NAA) regulators were applied during blooming by spraying the inflorescences or plunged them in whole (for about 5 seconds), and treatment applications were summarized in table 1.

Measured Parameters

The experiment evaluated yield quality of 'Superior Seedless' grape by analyzing the following parameters:

Cluster weight and length

Theaverage cluster weight and length were determined byweighing and measuring 15 typical clusters, with 5 clustersrandomly sampled from each plant.

Berry weight, number, length and width

The averageberry weight, number, length and width were determinedby weighing, counting and then measuring berriesfrom five medium-sized clusters from each replicate.

Extract content

Fruit extract content was measured using an Abbe refractometerand determining the percentage content ofextract in the juice solution, squeezing the juice out of 20 representative berries from each plant.

Experimental design and statistical analysis

The experimental design was a randomized complete block design (RCBD) and included 9 treatments with 5 replicates. Replicates were plots in which 3 plants grew as an experimental unit. The data were subjected to analysis of variance (ANOVA), according to procedures outlined by Steel and 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

Cluster weight

Applying the plant hormones demonstrated a beneficial effect on cluster weight in 'Superior Seedless' grape (Table 2). It was found that inflorescence's treated with 40 $mg.L^{-1}$ GA_3 and the mixture of 40 $mg.L^{-1}$ GA_3 + 0.2% NAA, irrespective of application method, as well as with 80 $mg.L^{-1}$ GA_3 by plunging, had significantly larger clusters than the control treated ones. The concentration of gibberellic acid and number of treatments were found to have a mild influence on the trait under study, whereas inflorescence's treated with a twice lower concentration had a slightly larger cluster weight than after a single application of the higher concentration. In many studies the effect of GA_3 on berry growth has not been fully explained (Zoffoli *et al*. 2009; Abu-Zahra, 2010). An optimal concentration of GA_3 mainly depends on weather conditions in addition to the particular growing season and on variety, and according to Casanova *et al*. (2009) its ranged from 160 to 260 $mg.L^{-1}$ as single application. Our results are in agreement with that obtained by Lu (1996), who found that grape vines treated with 40 $mg.L^{-1}$ GA_3 had slightly larger clusters than the control one, also vines treated with 80 $mg.L^{-1}$ GA_3 had the largest clusters.

Berry weight

Inflorescences treated withplant hormones produced slightly heavier berries than the control ones (Table 2). But, these differences were significant only in the case of the inflorescence's treated with 80 $mg.L^{-1}$ GA_3 by spraying. On the other hand,inflorescence's sprayed twice with the lower concentration were characterized by lower berry weight than after the application of 80$mg.L^{-1}$ GA_3. A similar beneficial effect of gibberellic acid on cluster and berry weight was shown by

Hyunggook *et al*. (2008), and Casanova *et al*. (2009).

Berries number per cluster

Inflorescences treated withthe plant hormones produced more berries per clusterthan the control ones (Table 2).Statistical analysis showed significant differences between inflorescencestreated with 40 mg.L^{-1}GA$_3$ and themixture of 40 mg.L^{-1}GA$_3$ + 0.2% NAA, irrespectiveof application method, as well as with 80 mg.L^{-1}GA$_3$ by plungeand the control treated vines.The concentration of gibberellic acid and numberof treatments were found to have a significant influence; inflorescences sprayed twicewith the lower concentration were characterized bya significantly higher number of berries per cluster thanafter the application of 80

Table 1. Treatment type, number and time of applications

Treatment type	Number of applications	Time of applications
0 mg.L^{-1} GA$_3$ (control)	Once	Full bloom (80% of faded flowers)
40 mg.L^{-1} GA$_3$	Twice	- First application at 20% of open flowers. - Second application at full bloom.
80 mg.L^{-1} GA$_3$	Once	Full bloom
40 mg.L^{-1} GA$_3$ + 0.2% NAA	Once	Full bloom
0.2% NAA	Once	Full bloom

Table 2. Cluster and berry weight, No. of berries and extract of 'Superior Seedless' grape depending on the method of application of gibberellic acid (GA$_3$) and naphthalene acetic acid (NAA) (means for 2006-2008)

Treatments	Cluster weight (gm)	Berry weight (gm)	No. of berries per cluster	Extract (º Brix)
Control	162 b	2.68 b	71.8 c	22.4 a
40 mg.L^{-1} GA$_3$ – spraying	335 a	3.01 ab	141.5 a	19.6 b
40 mg. L^{-1} GA$_3$ – plunge	341 a	3.06 ab	121 ab	19.6 b
80 mg. L^{-1} GA$_3$ – spraying	286 ab	3.50 a	92.7 bc	19.8 b
80 mg. L^{-1} GA$_3$ – plunge	318 a	3.18 ab	118.3 ab	20.0 b
0.2% NAA – spraying	212 ab	2.75 ab	85.4 bc	19.4 b
0.2% NAA – plunge	208 ab	2.88 ab	87.7 bc	22.2 a
40 mg. L^{-1} GA$_3$ + 0.2% NAA – spraying	330 a	3.38 ab	121 ab	19.9 b
40 mg. L^{-1} GA$_3$ + 0.2% NAA – plunge	322 a	3.45 ab	119.6 ab	20.6 ab

Means followed by the same letter are not significantly different at 0.05 probability level.

Table 3. Cluster length, berry length and berry width of 'Superior Seedless' grape depending on the method of application of gibberellic acid (GA$_3$) and naphthalene acetic acid (NAA) (means for 2011-2013)

Treatments	Cluster length (cm)	Berry length,(mm)	Berry width,(mm)
Control	16.7 cd	19.9 bc	17.7 ab
40 mg.L^{-1} GA$_3$ – spraying	17.7 bc	21.2 ab	17.9 ab
40 mg. L^{-1} GA$_3$ – plunge	19.2 a	22.8 a	17.7 ab
80 mg. L^{-1} GA$_3$ – spraying	18.4 ab	22.8 a	18.8 a
80 mg. L^{-1} GA$_3$ – plunge	18.9 a	23.2 a	18.8 a
0.2% NAA – spraying	16.0 d	18.8 c	17.1 ab
0.2% NAA – plunge	15.7 d	18.8 c	17.0 b
40 mg. L^{-1} GA$_3$ + 0.2% NAA – spraying	19.0 a	22.6 a	18.7 ab
40 mg. L^{-1} GA$_3$ + 0.2% NAA – plunge	19.3 a	23.0 a	18.5 ab

Means followed by the same letter are not significantly different at 0.05 probability level.

mg.$L^{-1}GA_3$.This coincides with earlier observations of Zoffoli *et al*. (2009), and Abu-Zahra (2010) who showed that the application of GA_3 increased berry set per cluster compared to the control.

Berries extract

Fruits treated with the growth regulators were characterized by lower extract content than the control ones (Table 2). In most of the treatments applied, it was observed that the vines whose inflorescences had been plunged in the solutions under investigation were characterized by slightly higher extract content than the sprayed ones.This is due to that seedless grapes do not have an adequate ability to uptake and concentrate sugar, as it is the case in seeded varieties(Casanova *et al*. 2009).

Cluster length

The length of 'Superior Seedless' grape clusters wereranged from 15.7 to 19.3 cm (Table 3). GA_3 and the mixture of 40mg.L^{-1} GA_3 + 0.2% NAAwere shown to have a significantly beneficial effect oncluster length; an exception were berries sprayed with 40mg.L^{-1} GA_3 whose lengthdid not differ significantly compared to the controlones. The treatment with 0.2% NAA was found to havean adverse effect on the tested quality parameter. Similar results were obtained by Abu-Zahra (2010) in which, the application of 50mg.L^{-1} GA_3 significantly increased cluster length in Seedless grape.

Berry length

Average berry length was ranged from18.8 to 23.2mm (Table 3). It was found that the application of $GA_3$and the mixture of 40mg.$L^{-1}GA_3$ + 0.2%NAA, irrespective of application method, had a beneficialinfluence on the berry length. The vines whoseinflorescences had been plunged in 40mg.L^{-1} $GA_3$and treated with 80mg.L^{-1} GA_3 and 40mg.L^{-1} GA_3+ 0.2% NAA, irrespective of application method, werefound to have significantly longer berries than the controlones. The plants treated with 0.2 % NAA wereshown to produce slightly shorter fruits than the controlones. This confirms earlier findings of Lu (1996) that demonstrated a positive influence of GA_3 on berry length in seedless varieties. It was observed that the investigated trait was slightly dependent on the concentration of GA_3 solution, as the fruits treated with 80mg.L^{-1} had slightly longer berries than in the case of 40mg.L^{-1}.

Berry width

In the present study, berry width was ranged from17 to 18.8 mm (Table 3).Statistical analysis did not show any significant differencesbetween berries treated with the solutions under investigation andthe control treatment. The plants treated with 0.2 %NAA were shown to produce slightly narrower berriesthan the control plants. In the case of most of the treatments, gibberellic acid and the mixture of 40mg.L^{-1} GA_3 + 0.2% NAA had a beneficial influence on the trait under study. This is confirmed by the study of Dokoozlian (1999) who showed a positive effect of GA_3on grape fruit size.

CONCLUSIONS

The applied plant hormone treatments on 'Superior Seedless' grape had a beneficial effect onberry and cluster weight as well as on the numberof berries per cluster. While itsslightly affected berry width. On the other hand, an adverse effect on the extract content of the 'Superior Seedless' fruit were observed. Gibberellic acid and the mixture of 40mg.L^{-1} GA_3+ 0.2% NAA were shown to have a significanteffect on cluster and berry length.An exception was clusters and berries sprayedwith 40mg.L^{-1} GA_3 that length did not differ significantlyin compare to the control treated vines.

REFERENCES

1. Abu-Zahra, T.R., Salameh, N.M. Influence of Gibberellic Acid and Cane Girdling on Berry Size of Black Magic Grape Cultivar. *Middle-East Journal of Scientific Research*, 2012; **11**(6): 718-722, ISSN 1990-9233.
2. Abu-Zahra, T.R. Berry size of 'Thompson Seedless' as influenced by the application of gibberellic acid and cane girdling. *Pak. J. Bot*., 2010; **42**(3): 1755-1760. ISSN:0556-3321.
3. Casanova, L., Casanova, R., Moret, A., Agusti, M. The application of gibberellic acid increases berry size of 'Emperatiz' seedless grape. *Span. J. Agric. Res*., 2009; 7(4): 919-927.ISSN: 1695-971-X
4. Conner, P.J. Performance of Muscadine Grape Cultivars in Southern Georgia. *Journal of the American Pomological Society*, 2009; **63**(3): 101-107. ISSN: 527-3741

5. Dokoozlian, N. Influence of Gibberellic acid berry sizing sprays on Crimson seedless table grape. University of California Cooperative Extension, Tulare County., 1999. http://cetulare.ucdavis.edu/pubgrape/tb897.htm.
6. Hyunggook, K., Donggeun, C., Inkyu, K. Effect of growth regulator treatments on quality andgrowth in 'Gailiangmeru' grape (*Vitis*spp.). *ActaHortic*., 2008; **772**: 319-322. ISSN:0567-7572
7. Korkutal, I., Bahar, E., Gokhan, O. The Characteristics of Substances Regulating Growth and Development of Plants and the Utilization of Gibberellic Acid (Ga3) in Viticulture. *World Journal of Agricultural Sciences*, 2008; **4**(3): 321-325. ISSN: 1817-3047.
8. Lu, J. Application of gibberellic acid on grape cultivar 'Orlando Seedless'. *Proc. Fla. State Hort. Soc*. 1996; **109**: 246-247.ISSN: 0097-1219.
9. Lu, J., Lamikanra, O., Leong, S., 1995. Effects of Gibberellic Acid on Muscandine Grape Production. *Proc.Fla.State Hort. Soc.,* 1995; **108**: 360-361. ISSN: 0097-1219.
10. Mullins, M.G., Bouquet, A., Williams,L.E., Biology of the grapevine. Cambridge University Press. 1992; ISBN-10: 0521305071.
11. Myœliwiec, R. Uprawawinoroœli. Plantpress, Kraków: 161 (in Polish). 2009; ISSN:0084-5477
12. Ollat, N., Diakou-Verdin, P., Carde, J.P., Bar –Rieu, F., Gaudillere, J.P., Moing, A. Grape berry development: *a review. J. Int. Sci. Vigne. Vin*. 2002; **36**: 109-131.ISSN : 1151-0285
13. Roper, T.R., Williams, L.E. Net CO_2 Assimilation and Carbohydrate Partitioning of Grapevine Leaves in Response to Trunk Girdling and Gibberellic Acid Application. *Plant Physiology*, 1989; **89**: 1136-1140.ISSN: 0176-1617
14. Steel, R. G. D., Torrie, J. H. Principles and Procedures of Statistics, McGraw-Hill, New York. 2nd edition. 1980; ISBN: 0070610282
15. Williams, L.E.,Ayars,J.E. 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*, 2005; **129**: 85-94.ISSN: 0168-1923
16. Zoffoli, J.P., Latorre, B.A., Naranjo, P. Preharvest applications of growth regulators and their effect on postharvest quality of Table Grapes during cold storage. *Postharvest Biology and Technology*, 2009; **51**(2): 183-192.ISSN: 0925-5214.