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FLAME SEEDLESS GRAPE VARIETY (*VITIS VINIFERA* L.) AND DIFFERENT CONCENTRATION OF GIBBERELLIC ACID (GA_3)

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Abstract

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Solutions of gibberellic acid prepared at three concentration levels including 5, 10 and 20 mg/L, were applied on Flame seedless grape variety, by spraying, during the three different periods of the vine growing: before blooming, after blooming and before veraison, in order to study their influence on some cultural technological characteristics. The dimension and shape of the cluster and berry, mechanical characteristics of the berries, chemical content of the must (sugar and total acids) and antocyanins have also been investigated. It was noticed that the concentration of gibberellic acid had an influence on the technological characteristics of the berries in the grape growing periods tested. The addition of gibberellic acid at the concentration of 20 mg/L increased the weight of the cluster and berry, and increased the transportability of the berries.

Key words: berry, cluster, Flame seedless, gibberellic acid

Introduction

The basic characteristic of modern table grape production is its adaptation to the requirements of the market aiming to improve grape quality, such as equal cluster size, equal size and shape of the berry, equal coloration of all the berries in the cluster and higher resistance to transportation. Furthermore, an important attribute of the grape berry quality is the seedlessness. Seedless cultivars are characterized with small grains and require management for improvement of their size.

In order to improve the grape quality and to increase the berry size, plant growth regulators are usually applied (Rumpai Nampila, 2010). Among the compounds used as plant regulators, gibberellc acid (GA_3) (Figure 1) has been extensively used to increase the berry size of seedless cultivars (Korkutal et al., 2007; Dimovska et al., 2011). Gibberellic acid promotes cell division, stimulates the earlier flowering, increases the size and yield of fruits, and induce seedlessness in the seedless cultivars. The effect of gibberellic acid depends on variety, concentration and time of application (Khan, 2009; Dimovska et al., 2006). In general, gibberellic acid affects the increasing of the grape berries mass when the plants are treated at 10-14 days after blooming, while for the seedless cultivars, the same effect is achieved when the treatment starts before the blooming phenophase (Okamoto and Iura, 2005; Marzouk and Kassem, 2002).The applications done in the periods of inflorescence and small grape berries reaching mm (10 days later than full blossom) make important effects on grape berry hardness and the elasticity of the skin (Yamada et al., 2003). GA_3 applied grape berries are more resistant to the cracks caused by the rains especially when it is close to harvest period (Dokoozlian, 2003).Color is

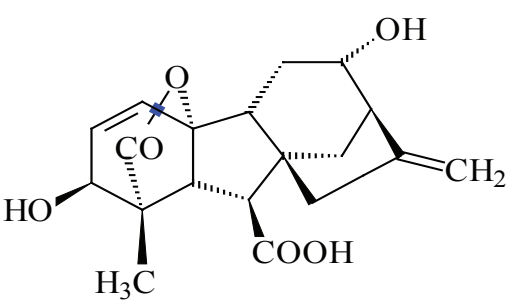

Fig. 1. Structure of gibberellic acid

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an important aspect of grape quality, especially for red, blue or black processed grapes. Coloration is due to anthocyanin accumulation in the skin berries of verasion stage (Korkutal et al., 2008).

The Republic of Macedonia has a Mediterranean and continental climate with a high number of completely dry days. The Vardar region is most famous for production of high quality table grape varieties, such as Cardinal, Dattier de Beyrouth, Italia, Michele Palieri, Muscato di Amburgo, Agadaj, Victotia, Valandovski drenak and some seedless grape varieties, such as Belgrade, Thompson, Flame, Rubi and Perletta (Dimovska et al., 2011). Although there are a large number of seedless grape varieties, no previous research has been performed on the effect of gibberellic acid on the growth of Macedonian grape cultivars. Therefore, the aim of this study was to examine the effect of gibberellic acid on the fruit development and the quality of grape on Flame seedless grape variety (international variety) grown in the Vardar region, R. Macedonia. The correlation of berry size, resistance, sugar and acids content provided information about the effect of the applied gibberellic acid on the vine plants (Figure 1).

Materials and Methods

Grape cultivar

Flame seedless grape varieties were grown in the Veles vineyards in the Vardar region, R. Macedonia. The grapevines were grafted to the rootstock Berlandieri x RipariaTeleci 8B, and the training system was pergola. The distance between the vines was 1.5 m and the distance between the rows was 3 m. These varieties were collected from 10-year-old vineyards. 21 clusters were collected from 30 vines. The samples were analyzed in duplicated, immediately after the harvest.

Experimental procedure

Experiments were performed during the 3 consecutive years (from2008 to 2010). Gibberellic acid (GA_3) was prepared at three concentration levels: 5 mg/L (C1), 10 mg/L (C2) and 20 mg/L (C3) and applied by spraying the grapevine on Flame seedless variety. The application of GA was performed as following:

Treatment 1 (G1): Three rows of vines were selected and each of them was treated at the same period of blooming, but with different concentrations of GA_3. Thus, the first row was treated with 5 mg/L GA_3, the second with 10 mg/L GA_3, and the third row was treated with 20mg/L GA_3. The application was performed 7-10 days before blooming and 7-10 days after blooming, for each concentration level of GA_3.

Treatment 2 (G2): Another three rows of vines were also treated at the same periods of blooming, by applying different concentrations of GA_3, 5, 10 and 20 mg/L GA_3. In this treatment, the different concentrations of GA_3 were applied 7-10 days before blooming, after blooming and before veraison for each row of the selected plants.

Treatment C: Control, included untreated plants.

The method of Prostoserdov has been used to measure the weight and size of the cluster and berries. The mechanical characteristics of the berry were determined on the technical scales. The content of sugar was determined using the Exlo's device, and the total amount of acids was determined by volumetric method, using 0.025 mol/L solution of NaOH.

One-gram anthocyanin from berry skin was blended with 95%ethyl alcohol and 1% HCl. The mixture was then filtered through a centered glass funnel G-3 and the extract was transferred to 25 ml volumetric flask and completed to volume with the acidified alcohol, then measured on spectrophotometer at a wavelength of 535 mm according to the method of Husia et al. (1965).

Statistical treatments, means, standard deviation and one-way ANOVA were performed using the XLSTAT Software, Version 2012.6.09, Addinsoft (Paris, France).

The student–Newman–Keuls of multiple comparisons of the mean values was applied to the results to ascertain possible significant differences between the studied grape samples.

Results and Discussion

Table 1 shows the fruit cluster characteristics of the Flame seedless grape variety, as affected by GA_3 application. As stated in the literature (Korkutalet al., 2008; Dimovska et al., 2011; Abu-Zahra, 2010), higher concentrations of gibberellic acid and increased number of treatments with GA_3, increase the weight of the cluster and the number of fertilized berries, thus improving the grape quality. Almost all GA_3 applications in this study were effective in increasing of the cluster weight, as well as of the number of fertilized berries from Flame seedless. Thus, the number of berry and fertilized berries was increasing with the increased concentration of the applied GA_3 in both treatments (T1-before blooming and after blooming; and T2 before blooming, after blooming and before veraison). With regard to the Flame variety, the weight of the cluster was increasing gradually, with the increasing of the concentration of applied GA_3 on the plants from both treatments. With regard to the form of the cluster (compared to the control), significant changes were observed for the variant with three treatments (G2) and highest concentration of gibberellic acid (C2, C3). Clusters change shape of conic-cylindrical characteristic of the variety to oval, which is most suitable for packing and packaging for longer transport.

The data in Table 2 show the results for the weight, dimension and form of berry of Flame seedless grape variety.

The increased berry mass is a result of the enhanced cell division and cell expansion. Furthermore, the increased berry weight, length and width of the Flame seedless variety were significant (compared to the control) when highest concentration of GA_3 was applied, was observed in both treatments (T1 and T2) the concentration of applied GA_3 on the plants from both treatments. On average, the weight of berries increased by 36% compared to control (C) in the treatments (G2) and a concentration of 20 mg/L (C3), where a statistical significance at the level of 0.05 was found.

The relation -length/width determines the shape of the berry). With regard to the form of the berry, no significant changes were observed for all treatments. Berries are keeping the oval shape -characteristic of this variety.

The average diameter determines the size of the berry. Flame seedless is among the varieties with small grains (Bozinovic, 2010). Because of treatment with giberrellic acid, there was an increase of dimensions (length, width) of berries and a change from the group of small berries into the group of varieties with medium size**.**

To sum up, the size of the treated berries in both treatments was changed, but the berry shape remained unchanged, compared to the control.

The data in Table 3 show the results for the resistance of pressure and breaking resistance of the Flame seedless variety. In general, the increased concentration of GA_3 and the increased number of treatments improved the mechanical properties of the berries. Thus, increasing of the pressure and breaking resistance was noticed with increasing of the concentration of the applied gibberellic acid. Furthermore, the best results in improving of the berry properties have been provided in the treatment when the highest concentration of gibberellic acid (20 mg/L) has been applied at the vines from Flame seedless variety. This effect was especially evident in the second treatment (T2), when GA_3 was applied three times on the vines. The resistance of pressure of berries was sig-

Table 1
Influence of gibberellic acid on the weight, dimension, formand number of berries/cluster

GA_3	Cluster					Number of berries		
	Weight, g	Index	Length, cm	Width, cm	L/W	Fertilized	Index	Unfertilized
C	244 ± 7.93a,b	100	17.5 ± 0.93a	7.96 ± 0.76a	2.20 ± 0.26a	133 ± 6.43a,b,c,d	100	32.0 ± 14.0
G1-C1	261 ± 9.86a,c	107	18.7 ± 1.01a	9.30 ± 0.44a,b	2.03 ± 0.06a	138 ± 2.08a	106	4.66 ± 4.16a
G1-C2	289 ± 6.03d	118	17.7 ± 0.87a	10.3 ±0.45b	1.70 ± 0.10	142 ± 11.59b	109	2.00 ± 2.00b
G1-C3	300 ± 11.8d	123	17.7 ± 0.72a	13.3 ± 0.62c,d	1.30 ± 0.10c	169 ± 9.54	131	3.33 ± 3.51b
G2-C1	262 ± 4.51b,c	107	16.5 ± 0.36a	10.6 ± 0.40b	1.56 ± 0.06b	146 ± 8.18c,e	112	17 ± 6.08
G2-C2	354 ± 23.5	145	17.9 ± 1.15a	12.8 ± 0.70d	1.40 ± 0.17b	156 ± 3.21d,e	120	4.33 ± 4.04a
G2-C3	405 ± 15.5	166	16.5 ± 0.62a	13.6 ± 0.71c	1.2 ± 0.08b,c	158 ± 15.71e	129	5.00 ± 2.64a

Labels: C (control); C1 - 5 mg/L GA_3; C2 – 10 mg/L GA_3, C3 – 20 mg/L GA_3, L/W – length/width
Results are average of three values ± SD (standard deviation)
Values with same letters in one column are not significantly different ($p>0.05$)

Table 2
Influence of gibberellic acid on the weight, dimension and form of berry

GA_3	Weight, g	Index	Length, cm	Width, cm	L/W (Berry chape index)	Average diameter
C	2.11 ± 0.39a	100	12.7 ± 0.65a	12.4 ± 0.53a	1.02 ± 0.07a	12.53 ± 0.39a
G1-C1	2.21 ± 0.17a	104	13.8 ± 0.58a,b	13.6 ± 0.40a,b	1.01 ± 0.07a	13.68 ± 0.19a
G1-C2	2.25 ± 0.22a	107	14.7± 0.61b	14.1 ± 0.42	1.03 ± 0.04a	14.16 ± 0.46a,b
G1-C3	2.38 ± 0.23a	109	14.2 ± 0.49b	15.1 ± 0.35	0.94 ± 0.03a	14.7 ± 0.33b
G2-C1	2.28 ± 0.03a	109	14.9 ± 0.52b	14.7 ± 0.65b	1.01 ± 0.08a	14.88 ± 0.12b
G2-C2	2.43 ± 0.29a,b	114	14.8 ± 0.81b	14.8 ± 0.72b	1.00 ± 0.07a	14.83 ± 0.54b
G2-C3	2.88 ± 0.19b	136	16.5 ± 0.47	16.7 ± 0.38	0.99 ± 0.02a	16.56 ± 0.51

Labels: C-control; C1 - 5 mg/L GA_3; C2 – 10 mg/L GA_3; C3 – 20 mg/L GA_3
Results are average of three values ± SD (standard deviation)
Values with same letters in one column are not significantly different ($p>0.05$)

nificantly higher when plants were treated three times (before blooming, after blooming and before veraison) with the highest concentration of GA_3 (20 mg/L). As a sum, in fact, the best mechanical characteristics of the berries from Flame seedless grape were achieved in the second treatment (G2), when the highest content of GA_3 (C3) was applied during the three periods of the vine growing.

Other important parameters that influence the grape quality are the content of sugar and the content of total acids (TA). Results from the influence of the GA_3 on the content of sugar and TA in the must are presented in Table 4. Concerning the effect of gibberellic acid on the vines applied at different concentrations, similar amounts of sugar have been found in the grapes of Flame variety, regardless of the concentration of GA_3 and the period of vine growing. The content of total acids (TA) determined in the grapes treated with the lowest concentration of GA_3 (in both treatments) was similar to the one found in the control grapes. Decreasing of the TA was observed when the highest concentration of gibberellic acid was applied at the plants. The obtained results were in accordance with the previously published data about the effect of gibberellic acid on the grape characteristics (Dimovska et al., 2011; Khan, 2009). Statistically significant differences were found in the variant with the highest concentration of gibberellic (C3) with three treatments (G2) over other variants.

The content of anthocyanins in the skin influences the organoleptic characteristics of table varieties and the time of harvesting.

The application of gibberellic acid (GA_3) is generally effective at increasing the anthocyanins content of grape including Flame seedless (Peppi et al., 2006).

The use of higher concentrations of GA_3 (over 50 ppm) leads to a reduction in the content of anthocyanins in berries (Rusaj, 2010) and this in turn has an adverse effect on the organoleptic properties of varieties with red and blue color of the skin intended for consumption in fresh condition.

The results of the influence of gibberellic acid on the content of anthocyanins are given in Table 5. Greater concentration of GA_3 affectsthe reduction of the content of anthocyanins (G_2, G_3). It is in the range of 23.9 mg/100g berries (G_3) to

Table 3
Influence of gibberellic acid on the mechanical function of the berry

GA_3	Resistance of pressure, g/cm^2	Index	Breaking of Resistance, g	Index
C	1431 ± 28.5a	100	216 ± 12.7a	100
G1-C1	1451 ± 43.7a	102	263 ± 8.73a	125
G1-C2	1620 ± 15.0b	113	278 ± 19.4a	129
G1-C3	1892 ± 16.1c	132	290 ± 15.0a	134
G2-C1	1468 ± 45.4a	103	285 ± 15.0a	132
G2-C2	1687 ± 15.3b	118	300 ± 13.2a	139
G2-C3	1942 ± 59.7c	136	307 ± 11.5a	142

Labels: C-control; C1 - 5 mg/L GA_3; C2 – 10 mg/L GA_3; C3 – 20 mg/L GA_3
Results are average of three values ± SD (standard deviation)
Values with same letters in one column are not significantly different ($p>0.05$)

Table 4
Influence of gibberellic acid on the content of sugar and total acids in the must

GA_3	Sugar, g/L	Index	Total acids, g/L	Index
C	225 ± 2.00a	100	5.7 ± 0.26a	100
G1-C1	221 ± 1.53a	98	6.2 ± 0.25a	109
G1-C2	222 ± 3.46a	99	6.2 ± 0.40a	109
G1-C3	230 ± 0.01a	102	4.7 ± 0.25b	84
G2-C1	229 ± 1.15a	101	6.1 ±0.36a	107
G2-C2	264 ± 49.4a	104	5.7 ± 0.75a	100
G2-C3	231 ± 3.61a	103	4.8 ± 0.20b	84

Labels: C-control; C1 - 5 mg/L GA_3; C2 – 10 mg/L GA_3; C3 – 20 mg/L GA_3
Results are average of three values ± SD (standard deviation)
Values with same letters in one column are not significantly different ($p>0.05$)

Table 5
Influence of gibberellic on the content of anthocyanins

GA_3	Anthocyanines g/100 g berries	Index
C	26.4 ± 3.15a	100
G1-C1	29.3 ± 1.11a	111
G1-C2	27.0 ± 2.59a	102
G1-C3	26.0 ± 5.27a	95
G2-C1	28.5± 3.02a	107
G2-C2	25.1 ± 2.89a	95
G2-C3	23.9 ± 1.02a	91

Labels: C-control; C1 - 5 mg/L GA_3; C2 – 10 mg/L GA_3; C3 – 20 mg/L GA_3
Results are average of three values ± SD (standard deviation)
Values with same letters in one column are not significantly different ($p>0.05$)

29.3 mg/100 g berries.No statistically significant difference was found among the variants. This proves that the concentration of gibberellic acid affects the improvement in grape quality and it does not affect the delay time of harvest, i.e. the grape ripens in time.

Conclusion

As a conclusion, the gibberellic acid applied at the vines in a higher concentration increased the berry mass and thus, the mass of the cluster. In addition, the increased number of fertilized berries has been also noticed when GA_3 has been applied in a highest level. The resistance of pressure and breaking resistance was improved when plants were treated three times (before blooming, after blooming and before verasion) with the highest content of GA_3. It was noticed that gibberellic acid had no significant influence on the content of sugar and content of total acids in the grape must. In general, the best results, in terms of a highest mass of the cluster, highest number of fertilized berries, as well as pressure and breaking resistance, were obtained with the T2-treatment, when the gibberellic acid was applied at highest concentration.

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