EFFECT OF CPPU, GA_3 AND NAA ON SOME QUALITY PARAMETERS OF RUBY SEEDLESS GRAPES

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ABSTRACT

CPPU, GA_3 and NAA were applied separately or in combination to bunches of Ruby Seedless grapes during two successive years (1998 and 1999). All concentrations of CPPU (2.5 & 5 ppm), GA_3 (20 & 40 ppm) and NAA (2 & 4 ppm) reduced soluble solid content (SSC) and SSC/acid ratio significantly. The effect of CPPU in reducing SSC was more evident than GA_3 and NAA in the first season, while in the second one the difference between them in this respect was little. Regarding titratable acidity content (TA), berries of all NAA and CPPU treatments contained higher TA than the control, while the effect of GA_3 was not significant. Both CPPU and GA_3 treatments increased cluster weight, berry firmness, berry length, berry diameter, receptacle diameter, pedicel diameter and berry removal force. The effect of NAA on cluster weight, receptacle diameter, berry removal force was not significant. Berry firmness of the NAA treatment was significantly lower than the unsprayed one.

INTRODUCTION

Berry size and cluster conformation of seedless grapes are customarily improved through the application of growth regulators (Reynolds *et al.*, 1992).

Gibberellic acid treatments of grapes has been used widely since 1960's for this purpose (Weaver, 1976). Moreover, auxins have been also taken in consideration to improve grape quality (Weaver, 1976), but the response was variable in different areas, which could be due to environmental factors, concentration or dates of application.

There is some reports indicating that the use of a combination of GA × NAA is more effective than the use of either compound alone in improving size of seedless grapes (Luckwill, 1959 and El-Hammady & Abdel-Hamid, 1995). Lately, CPPU [N-(2-chloro-4-pyridinyl)-N-phenylurea] was found to be effective in increasing berry size of several grape cultivars (Nickell, 1985, 1986a, 1986b). This beneficial effect of CPPU was enhanced by GA_3 (Nickell, 1985 and Morris *et al.*, 1986). CPPU could be used at very low concentration, yet still powerfull, and is used months ahead of harvest to eliminate product residues (Reynolds *et al.*, 1992).

This investigation was carried out to study the effect of CPPU, GA_3 and NAA either solely or in combinations on fruit quality of Ruby Seedless grapes and to find out if there is any possible additive effect of these compounds in this respect.

MATERIALS AND METHODS

This experiment was conducted during the 1998 and 1999 seasons on a Ruby Seedless vineyard located at El-Mahala El-Kubra, Gharbia governorate. These vines were cordon trained and spur pruned at 60 buds/vine (30 spurs). Vines were selected to be as uniform as possible in their vegetative and number of cluster per vine.

Solutions of all possible combinations of CPPU [N-(2-chloro-4-pyridinyl)-N-phenylurea], known as Sitofex, from SKW Trostberg Aktiengesellschaft, Germany (0, 2.5 and 5 ppm), GA_3 (0 and 40 ppm in 1998 and 0, 20 and 40 ppm in 1999) and NAA (0, 2 and 4 ppm) were prepared just before application. Clusters of vines assigned for each treatment were sprayed using a hand gun sprayer when berry diameter was 4-6 mm.

Each treatment was represented by three vines plot in three replicates arranged in a randomized complete block design. Guard rows separated all treatments.

Treated clusters were harvested when soluble solid content of the control was 16.6% in the first season and 16.9% in the second one.

The following parameters were determined:

- Soluble solid content (SSC), by hand refactometer.
- Titratable acidity (TA), as tartaric acid (A.O.A.C., 1980).
- SSC/acid ratio was calculated.
- Cluster weight (g).
- Berry diameter (mm), berry length (mm), receptacle diameter (mm) and pedicel diameter (mm).
- Berry removal force (gf) and berry firmness (gf), using Effegi pentrometer with 2 mm plunger.

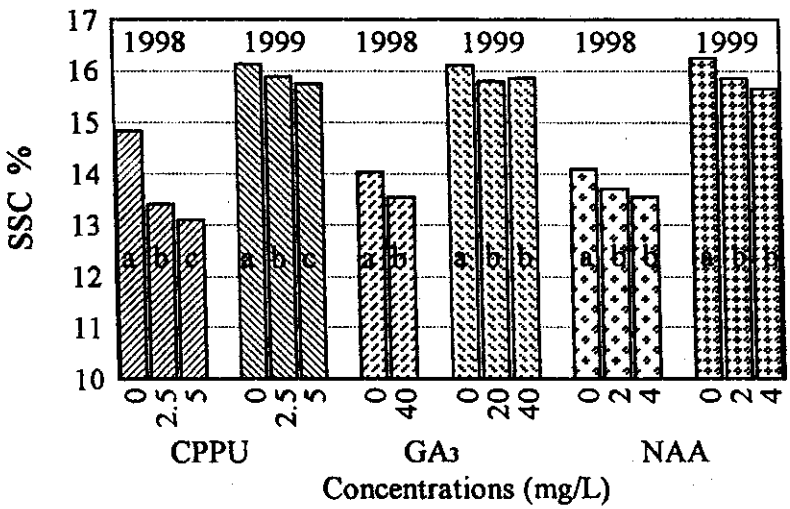
The data were statistically analyzed according to the method of Snedecor and Cochran (1980) as means were compared using Duncan's multiple range test.

RESULTS

Soluble solid content (SSC):

During the both seasons, CPPU at 2.5 & 5 ppm decreased SSC in Ruby Seedless grapes significantly (Fig. 1). SSC was the lowest at 5 ppm with significant difference as compared with the 2.5 ppm treatment in the two seasons. Also GA_3 treatments at 20 & 40 ppm reduced SSC significantly during the two seasons, but the difference between 20 and 40 ppm was not significant (Fig. 1). The same trend was also observed for NAA treatments at 2 and 4 ppm as it reduced SSC significantly than the control, while the difference between the two NAA concentrations was not significant (Fig. 1).

Fig. (1): Effect of concentrations of CPPU, GA_3 and NAA on soluble solids content (SSC %) of Ruby Seedless grapes during 1998 and 1999 seasons.



Bars designated by the same letters in the same group are not significantly different at 5 % level according to DMRT.

The data in Table (1) show the interactions between GA_3, NAA and CPPU treatments. Concerning the interaction between GA_3 and NAA treatments in the first season, the highest SSC was recorded in the control, while the lowest content was for the 40 ppm GA_3 + 4 ppm NAA treatment. The difference between them was significant. The same trend was observed in the second season.

The interaction between CPPU and NAA showed that the control had the highest SSC, while the lowest values were observed in the 5 ppm CPPU + 4 ppm NAA treatment with a significant deference in the second season.

Regarding the interaction between CPPU and GA_3, there were no significant differences in the first season, while in the second one there were significant interactions with the highest SSC in the 5 ppm CPPU + 0 ppm GA_3 and the lowest in the 5 ppm CPPU + 40 ppm GA_3 treatments.

Table (1): Effect of CPPU, GA_3 and NAA interaction on soluble solids content (SSC%) of Ruby Seedless grapes during 1998 and 1999 seasons.

Treatments		1998			1999			
NAA (N) mg/l	CPPU (C) mg/l	GA_3 (G) mg/l		CxN means	GA_3 (G) mg/l			CxN means
		0	40		0	20	40	
0	0	16.56 a	14.34 bc	15.45 a	16.95 a	16.37bcd	16.37bcd	16.56 a
0	2.5	13.92 cd	13.42 de	13.67 c	16.17 b-e	15.37 fgh	16.17 b-e	15.90 cd
0	5	13.40 de	12.86 ef	13.13 d	16.53 b	16.13 b-e	16.13 b-e	16.27 b
GxN means		14.63 a	13.54 bc		16.55 a	15.96 cd	16.22 b	
2	0	14.68 b	14.50 bc	14.59 b	16.13 b-e	15.80 efg	16.20 b-e	16.04 bc
2	2.5	13.14 ef	13.46 de	13.30 cd	15.77 efg	15.73 efg	15.87 e	15.79 cd
2	5	13.32 de	13.06 ef	13.19 d	16.43 bc	15.38 fgh	15.20 hi	15.67 d
GxN means		13.71 b	13.67 bc		16.11 bc	15.64 e	15.76 de	
4	0	14.46 bc	14.44 bc	14.45 b	15.33 ghi	16.13 b-e	15.83 ef	15.77 d
4	2.5	13.46 de	12.94 ef	13.20 d	15.83 ef	15.93 de	15.97 cde	15.91 cd
4	5	13.26 ef	12.66 f	12.96 d	15.70 efg	15.13 hi	14.90 i	15.24 e
GxN means		13.73 b	13.35 c		15.62 e	15.73 de	15.57 e	
CxG means	0	15.23 a	14.43 a		16.14 ab	16.10 ab	16.13 ab	
	2.5	13.51 a	13.27 a		15.92 bc	15.68 cd	16.00 ab	
	5	13.33 a	12.86 a		16.22 a	15.55 de	15.41 e	

For each season, means of each interaction (SxN, GxN, SxG and SxNxG) followed by a common letter are not significantly different at the 5% level by DMRT.

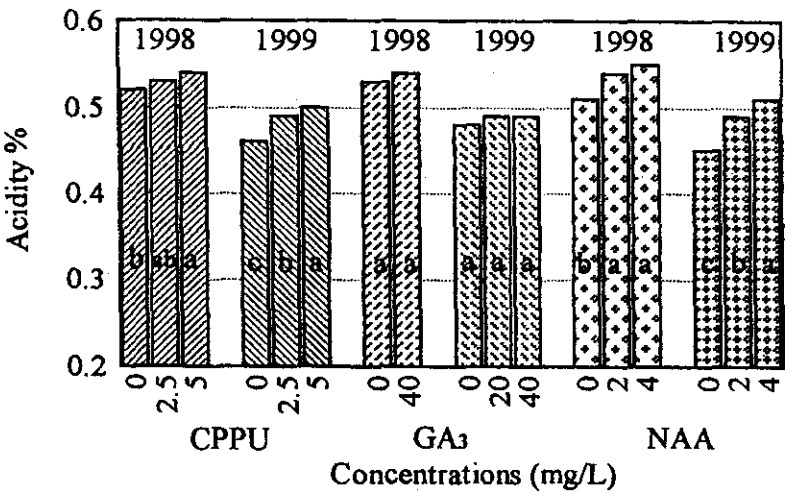
Titratable acidity (TA):

As indicated in Figure (2), titratable acidity content (TA) of the 5 ppm CPPU treatment was significantly higher than the control in both seasons. Differences in TA were significant between 2.5 ppm CPPU and each of unsprayed and 5 ppm CPPU treatments in the second season.

The effect of GA_3 concentrations on TA was not significant in both seasons.

NAA treated clusters had significantly higher TA than those of the control. While the difference between both NAA concentrations were not significant in 1998, whereas in 1999, the 4 ppm treatment gave significantly higher TA than the 2 ppm.

Fig. (2): Effect of concentrations of CPPU, GA_3 and NAA on acidity of Ruby Seedless grapes during 1998 and 1999 seasons.



Bars designated by the same letters in the same group are not significantly different at 5 % level according to DMRT.

The interaction between GA_3 and NAA concentration was significant (Table 2). The highest significant interaction was in the 40 ppm GA_3 + 4 ppm NAA treatment in both seasons.

Concerning the interaction between CPPU and NAA concentrations, the highest interaction on TA was in the 5 ppm CPPU + 4 ppm NAA treatment (Table 2).

The interaction between CPPU and GA_3 was not significant in the first season, while it was significant in the second one (Table 2). CPPU at 5 ppm + 0 ppm GA_3 gave the highest TA.

SSC/acid ratio :

CPPU treatments significantly reduced SSC/acid ratio during the two seasons. The effect of 5 ppm was more pronounced in this regard than the 2.5 ppm treatment (Fig. 3).

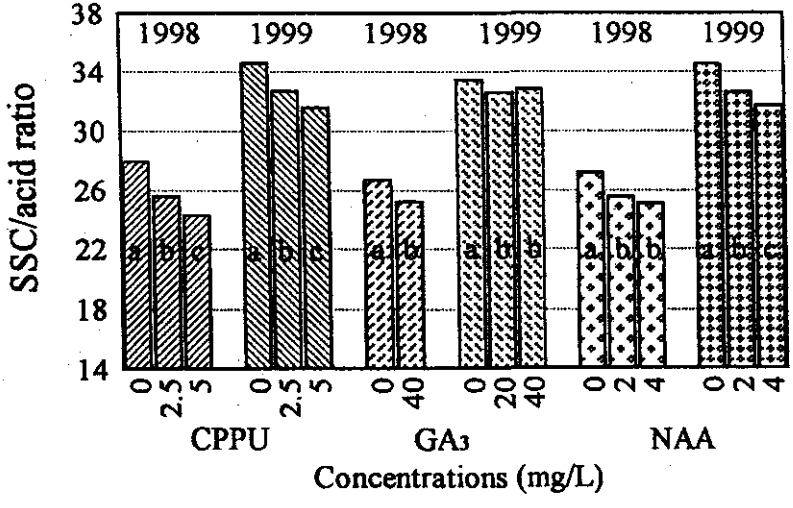
Concerning GA_3 treatments, 40 ppm treatment reduced the SSC/acid ratio significantly than the control in both seasons (Fig.3). The difference between 20 ppm and 40 ppm GA_3 treatments, in the second season, was not significant in this regard.

Table (2): Effect of CPPU, GA_3 and NAA interaction on acidity % of Ruby Seedless grapes during 1998 and 1999 seasons.

Treatments		1998			1999			
NAA (N) mg/l	CPPU (C) mg/l	GA_3 (G) mg/l		CxN means	GA_3 (G) mg/l			CxN Means
		0	40		0	20	40	
0	0	0.50 d	0.51 cd	0.50 a	0.44 ij	0.46 ghi	0.47 fgh	0.45 d
0	2.5	0.52 cd	0.52 cd	0.52 a	0.43 j	0.45 hij	0.44 ij	0.44 d
0	5	0.53 cd	0.51 cd	0.52 a	0.47 fgh	0.48 efg	0.45 hij	0.47 c
GxN means		0.52 cd	0.51 d	0.53 a	0.44 d	0.46 c	0.45 cd	
2	0	0.54 bc	0.52 cd	0.53 a	0.46 ghi	0.49 def	0.46 ghi	0.47 c
2	2.5	0.53 c	0.52 cd	0.52 a	0.50 cde	0.50 cde	0.52 bc	0.50 b
2	5	0.54 bc	0.57 a	0.55 a	0.50 cde	0.51 cd	0.49 def	0.50 b
GxN means		0.54 b	0.54 b	0.54 a	0.49 b	0.50 ab	0.49 b	
4	0	0.53 c	0.54 bc	0.54 a	0.46 ghi	0.48 efg	0.46 ghi	0.47 c
4	2.5	0.53 c	0.56 ab	0.55 a	0.50 cde	0.50 cde	0.55 a	0.52 a
4	5	0.54 bc	0.58 a	0.56 a	0.55 a	0.50 cde	0.54 ab	0.53 a
GxN means		0.53 bc	0.56 a		0.50 ab	0.50 ab	0.51 a	
CxG means	0	0.52 a	0.52 a		0.45 f	0.48 cd	0.46 ef	
	2.5	0.53 a	0.53 a		0.47 de	0.48 cd	0.50 ab	
	5	0.53 a	0.55 a		0.51 a	0.50 ab	0.49 bc	

For each season, means of each interaction (SxN, GxN, SxG and SxNxG) followed by a common letter are not significantly different at the 5% level by DMRT.

Fig. (3): Effect of concentrations of CPPU, GA_3 and NAA on SSC/acid ratio of Ruby Seedless grapes during 1998 and 1999 seasons.



Bars designated by the same letters in the same group are not significantly different at 5 % level according to DMRT.

NAA Treatments significantly reduced SSC/acid ratio during the both seasons (Fig. 3). The difference between 2 ppm and 4 ppm NAA treatments was significant in the second season.

There was significant interaction between GA_3 & NAA treatments (Table 3), where the significantly lowest SSC/acid ratio was recorded in the 40 ppm GA_3 + 4 ppm NAA treatment in both seasons. The same trend was observed in the 20 ppm GA_3 + 2 or 4 ppm NAA in the second season.

Data presented in Table (3) indicated also that there were significant interactions between CPPU and NAA on SSC/acid ratio. Combination of both CPPU and NAA had significantly lower SSC/acid ratio, the lowest SSC/acid ratio was observed in the 5 ppm CPPU + 4 ppm NAA and 5 ppm CPPU + 2 ppm NAA, in both seasons.

Concerning the interaction between CPPU and GA_3 (Table 3), the same trend was observed during both seasons, where the lowest ratio was that of the 40 ppm GA_3 + 5 ppm CPPU treatment.

Table (3): Effect of CPPU, GA_3 and NAA interaction on SSC/ acid ratio of Ruby Seedless grapes during 1998 and 1999 seasons.

Treatments		1998			1999			
NAA (N)	CPPU (C)	GA_3 (G) mg/l		CxN Means	GA_3 (G) mg/l			CxN Means
mg/l	mg/l	0	40		0	20	40	
0	0	33.26 a	26.29 b-f	29.77 a	37.98 a	35.89 b	34.70 bcd	36.19 a
0	2.5	26.67 bcd	26.08 b-f	26.38 c	33.15 e-h	32.47 fgh	35.80 b	33.81 bc
0	5	25.21 efg	25.46 d-g	25.34 d	33.76 def	32.28 f-i	34.38 cde	33.47 c
GxN means		28.38 a	25.94 b		34.96 a	33.55 b	34.96 a	
2	0	27.28 bc	27.40 b	27.34 b	34.80 bcd	32.61 fgh	35.59 bc	34.33 b
2	2.5	24.70 gh	25.93 c-g	25.31 d	31.84 hij	32.21 ghi	32.48 fgh	32.18 d
2	5	24.97 fgh	22.93 ij	23.95 e	33.01 e-h	30.41 k	29.87 k	31.10 e
GxN means		25.65 b	25.42 b		33.22 bc	31.74 e	32.64 cd	
4	0	26.38 b-e	26.85 bc	26.61 bc	33.08 e-h	33.41 d-g	32.79 fgh	33.09 c
4	2.5	26.22 b-f	23.80 hi	25.01 d	31.84 hij	33.24 e-h	30.59 jk	31.89 d
4	5	25.23 efg	22.03 j	23.63 e	30.99 ijk	30.46 jk	28.35 l	29.93 f
GxN means		25.94 b	24.23 c		31.97 de	32.37 de	30.58 f	
CxG means	0	28.97 a	26.85 b		35.29 a	33.97 b	34.36 b	
	2.5	25.86 c	25.27 cd		32.27 c	32.64 c	32.96 c	
	5	25.14 d	23.47 e		32.58 c	31.05 d	30.87 d	

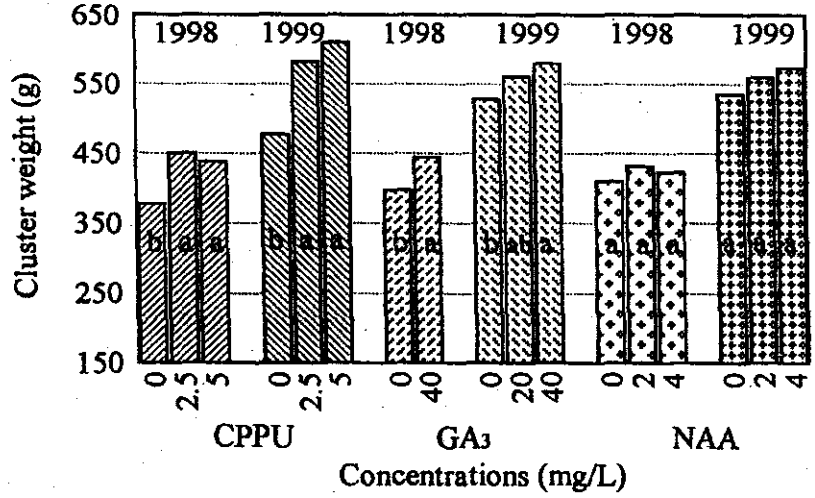
For each season, means of each interaction (SxN, GxN, SxG and SxNxG) followed by a common letter are not significantly different at the 5% level by DMRT.

Cluster weight (g) :

Both CPPU and GA_3 treatments increased cluster weight significantly (Fig. 4). The difference between CPPU concentrations was not significant in

both seasons. The difference between 0 and 40 ppm GA_3 was significant, while it was not significant between 0 and 20 ppm, and also between 20 and 40 ppm. The effect of NAA concentrations was not significant in both seasons (Fig. 4)

Fig. (4): Effect of concentrations of CPPU, GA_3 and NAA on cluster weight (g) of Ruby Seedless grapes during 1998 and 1999 seasons.



Bars designated by the same letters in the same group are not significantly different at 5 % level according to DMRT.

Berry length and berry diameter (mm):

Generally, CPPU, GA_3 and NAA treatments increased length and diameter of berries in both seasons (Table 4). The difference between 2.5 and 5 ppm CPPU was not significant in the first season for both berry length and berry diameter, while it was significant in the second season.

Regarding the effect of GA_3 concentrations, there was significant difference between 0 and 40 ppm, in the first season, and 0, 20 and 40 ppm in the second one for both length and diameter of berries (Table 4).

Concerning the effect of NAA concentrations, in the first season, the difference between 2 ppm and 4 ppm treatments was not significant, while both of them were significantly higher than 0 ppm treatment for both length and diameter of berries (Table 4). In the second season, the differences among the concentrations were not significant.

Table (4): Effect of CPPU, GA_3 and NAA concentrations on berry length (mm), berry diameter (mm), receptacle diameter (mm), pedicel diameter (mm), firmness (gf) and berry removal force (gf) of Ruby Seedless grapes during 1998 and 1999 seasons.

TREATMENTS		Berry length (mm)		Berry diameter (mm)		Receptacle diameter (mm)		Pedicel diameter (mm)		Firmness (gf)		Berry Removal force (gf)	
	mg/L	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999
CPPU (C)	0	18.52 b	19.86 c	16.11 b	16.69 c	2.52 b	2.80 c	1.36 c	1.72 c	497 b	424 b	380 b	372 c
	2.5	19.19 a	20.71 b	16.97 a	17.55 b	2.81 a	3.27 a	1.57 b	1.88 b	517 a	423 b	393 b	401 b
	5	19.11 a	21.10 a	16.94 a	18.15 a	2.87 a	3.32 a	1.68 a	2.01 a	518 a	439 a	427 a	435 a
Sig.		**	**	**	**	**	**	**	**	**	**	**	**
GA_3 (G)	0	18.77 b	19.99 c	16.49 b	17.01 c	2.66 b	2.89 b	1.42 b	1.59 b	512	432	404	407
	20	-	20.59 b	-	17.43 b	-	3.22 a	-	1.99 a	-	430	-	399
	40	19.11 a	21.09 a	16.86 a	17.84 a	2.81 a	3.28 a	1.65 a	2.03 a	510	425	396	402
Sig.		*	**	**	**	**	**	**	**	NS	NS	NS	NS
NAA (N)	0	18.53 b	20.52	16.40 b	17.34	2.70	3.10	1.43 b	1.85	514 a	436 a	408	406
	2	19.27 a	20.68	16.94 a	17.52	2.79	3.14	1.57 a	1.89	515 a	430 ab	400	403
	4	19.02 a	20.47	16.68 a	17.43	2.71	3.15	1.61 a	1.86	503 b	421 b	392	399
Sig.		**	NS	**	NS	NS	NS	**	NS	**	**	NS	NS
Interactions													
NxG		*	NS	NS	NS	*	NS	**	NS	**	**	NS	NS
NxC		NS	*	NS	NS	*	NS	*	NS	NS	NS	**	NS
GxC		**	**	NS	NS	**	**	NS	**	*	*	NS	**
NxGxC		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**

In a column, means in each group followed by a common letter are not significantly different at 5% level according to DMRT.

Receptacle diameter (mm):

During both seasons, CPPU and GA_3 treatments increased receptacle diameter significantly (Table 4). The differences among the concentrations were not significant. The NAA treatment increased receptacle diameter, but it did not reach significant level.

Pedicel diameter (mm):

Both CPPU and GA_3 treatments increased pedicel diameter significantly in both seasons (Table 4). The differences between GA_3 concentrations were not significant, while pedicel diameter of 5 ppm CPPU treatment was significantly higher than that of 2.5 ppm treatment.

Regarding NAA effect, it increased pedicel diameter significantly in the first season, while in the second season, it did not reach significant level (Table 4).

Berry firmness (gf):

Berry firmness of the 5 ppm CPPU treatment, in both seasons, and 2.5 ppm CPPU in the second one was significantly higher than the non sprayed cluster (Table 4). The deference between 2.5 and 5 ppm CPPU treatments was not significant in the first season, while it was significant in the second one. The effect of GA_3 treatments on berry firmness was not significant in both seasons (Table 4). The 4 ppm NAA treatment showed the lowest significant berry firmness in both seasons. The difference between 4 ppm and 2 ppm NAA treatments was significant in the first season, but it was not significant in the second one.

Berry removal force (gf):

CPPU spray increased berry removal force significantly during the two seasons (Table 4). The berry removal force of 5 ppm treatment was significantly higher than 2.5 ppm treatment in the two seasons.

The effect of GA_3 and NAA treatments in this regard were not significant (Table 4).

DISCUSSION AND CONCLUSION

Growth hormones are known to play an important role in growth and development of fruits (Weaver, 1972). The results presented here indicated that GA_3 and/or CPPU increased fruit size, and the interaction between both regulators in this respect was significant. Moreover, GA_3, CPPU or NAA

increased berry length and diameter. These results are in accordance with those of Saad *et al.* (1979); Mahmoud *et al.* (1989); Sohan-Singh *et al.* (1992) and Zabadal & Bukovac (2000). It was also found that the receptacle and pedicel diameter were significantly increased by CPPU and GA_3 in both seasons and NAA in the first season only with respect to pedicel diameter. Such finding has its importance in improving post-harvest handling of clusters. This is reflected in an increased berry removal force, which eliminate berry shutter during handling. These results support the findings of Singh *et al.* (1978); Youssef *et al.* (1983) and Abdel-Kawi (1984) in this regard.

Moreover, the used growth regulators delayed maturity as indicated by reduced SSC and SSC/acid ratio and increased berry firmness. Similar findings were reported by Yakushiji *et al.* (2000). The interaction of different growth regulators in these prementioned effects was evident.

The conclusion could be reached that the use of combination treatment of GA_3 (20 ppm), CPPU (2.5-5 ppm) and NAA (2 ppm) is recommended for improving seedless grape quality for better marketability and income.

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الملخص العربي

تأثير الـ CPPU وحمض الجبريليك ونفثالين حمض الخليك على بعض صفات الجودة لثمار العنب الروبى سيدلس

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أجريت هذه الدراسة بمزرعة خاصة بالمحلة الكبرى – محافظة الغربية خلال موسمى ١٩٩٨ ، ١٩٩٩ لدراسة تأثير الرش بكل من الـ CPPU، وحمض الجبريليك (GA_3)، ونفثالين حمض الخليك (NAA) على بعض صفات الجودة لثمار العنب الروبي سيدلس، تم رش العناقيد للأشجار المختارة بإحدى التوليفات الممكنة من المواد المستخدمة حيث استخدم الـ CPPU بتركيزات صفر ، ٢.٥ ، ٥ جزء في المليون وحمض الجبريليك بتركيزات صفر ، ٤٠ جزء فى المليون فى الموسم الأول وبتركيزات صفر ، ٢٠ ، ٤٠ جزء فى المليون فى الموسم الثانى ونفثالين حمض الخليك بتركيزات صفر ، ٢ ، ٤ جزء فى المليون، وقد رشت العناقيد عندما كان قطر الحبات ٤–٦مم.

وتم تقدير الصفات التالية: المواد الصلبة الذائبة الكلية – الحموضة – نسبة المواد الصلبة الذائبة الكلية إلى الحموضة – وزن العنقود – قطر وطول الحبات – قطر عنق الحبة وقطر التخت – قوة شد الحبات – الصلابة.

ويمكن تلخيص أهم النتائج المتحصل عليها فى الآتى:
- كانت نسبة المواد الصلبة الذائبة الكلية فى معاملات الـ CPPU وحمض الجبريليك ونفثالين حمض الخليك أقل مقارنه بالعناقيد غير المرشوشة وكان ذلك أكثر وضوحا فى معاملات الـ CPPU.
- زادت الحموضة فى معاملات الـ CPPU ونفثالين حمض الخليك مقارنة بالعناقيد غير المرشوشة بينما لم يكن لحمض الجبريليك تأثير معنوى فى هذا الصدد.
- أوضحت النتائج زيادة فى وزن العنقود والصلابة وطول وقطر الحبة وقطر عنق الحبة وقطر التخت وقوة شد الحبات وذلك فى المعاملات المرشوشة بالـ CPPU وحمض الجبريليك.
- لم يكن هناك اتجاه واضح لتأثير الرش بنفثالين حمض الخليك علي قطر التخت وقوة شد الحبات بينما كانت هناك زيادة غير معنوية فى وزن العنقود وانخفاض معنوى فى صلابة الحبات.
- ويوصى باستخدام الـ CPPU بتركيزات ٢,٥–٥ جزء فى المليون وحمض الجبريليك بتركيز ٢٠ جزء فى المليون ونفثالين حمض الخليك بتركيز ٢ جزء فى المليون رشا على العناقيد عندما يكون قطر الحبات من ٤–٦ مم وذلك لتحسين صفات الجودة لثمار عنب الروبي سيدليس وتحسين الصفات التسويقية وتحقيق أكبر عائد اقتصادى.