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EFFECT OF SOME GIBBERELLIC ACID AND FORCHLORFNURON APPLICATION ON PRODUCTIVITY AND BERRIES DEVELOPMENT OF EARLY SWEET GRAPES

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ABSTRACT: This study was conducted during the two consecutive seasons of (2016 and 2017) in a private vineyard located at El-Sadat City, Menoufia Governorate, to study the effect of gibberellic acid (GA_3) and forchlorfnuron (CPPU) application on productivity and berries development of Early Sweet grape cultivar. The vines were five years old, spaced at 2×3 meters apart, grown in a sandy soil and trellised according to the Spanish Parron system.

Eight treatments were applied by using dipping clusters with CPPU at concentrations from 1 to 7ppm after fruit set directly in combined plus spraying with GA_3 at 20 ppm at 6-8mm berry diameter in additionally control treatment. The results revealed that all CPPU and GA_3 applications had the best results in comparison with control in both seasons. Excessive CPPU doses + spraying clusters with GA_3 increases yield and physical properties of berries *i.e.* berry weight, size and firmness, but it delay maturation. In contrast, lower CPPU doses + spraying clusters with GA_3 cause a slightly in retarding maturation but reduces yield and its components. On the other hand, moderate CPPU doses (dipping clusters with CPPU at 5 ppm + spraying clusters with GA_3 at 20 ppm) had an achieving in appropriate balance between yield and cluster quality attributes of Early Sweet grapevines in both seasons.

Key words: Grapes, Early Sweet, gibberellic acid, forchlorfnuron, cluster, productivity, berries quality, attributes

INTRODUCTION

Grapes are among the most important and popular fruit in Egypt and the whole world, for being nice test, Excellent flavor and high nutritional value. In Egypt the grapes occupies the second position after citrus in terms the export importance of grapes in Egypt, and its high profitability. According to the latest Ministry of Agriculture statistics (2018), Egypt's total grape area reached 202655 feddans, with a production of 1892993 tons.

Early Sweet is one of the most important table grape varieties, It is earliest white seedless table grapes and successfully grown under Egypt conditions, but natural berry size of Early Sweet in not large enough for export and profitable trading, so, farmers must be use growth regulators gibberellic acid and sitofex and other synthetic growth stimulants to increase size berry grapes without any health or environment hazards which, can be the most advantageous in marketing and export table grapes.

Quality improvement is an important gauge in viticulture which could be accomplished with the aid of various plant growth regulators. Among the used plant growth regulators, gibberellic acid and forchlorfnuron or sitofex play a significant role for enhancing crop of grapes in terms of both quantity and quality that meet export requirements (Senthilkumar *et al.,* 2018).

Applications of gibberellic acid (GA_3) lead to cell division and cell enlargement as well as increase the biosynthesis of proteins and producing new tissues promoting the water and nutrients absorption which will lead to increase the cluster length as well as, berry size and weight. (Abu-Zahra and Salameh, 2012 and Abada *et al.,* 2015 and Belal, 2019).

Forchlorfnuron (CPPU) or sitofex a member of the synthetic cytokinin group with phenyl urea structure (Arima *et al.,* 1995). CPPU or N - (2 – Chloro – 4 - pyridyl) - N - phenylurea) have successfully improved fruit size in different fruit crops (Hota *et al.,* 2017). The enhancement effect of CPPU on fruit size is due to stimulating cell division in the early stage and promoting cell enlargement in the late stage of fruit development (Hajam *et al.,* 2018). Moreover, CPPU applications recorded numerous advantages as lick leading fruits more firmly and to more round or oval shape (El Abbasy *et al.,* 2015).

Previous studies indicated that the combined treatment of GA_3 and CPPU increased the yield, improved berry physical properties and delaying berry maturation greater than of each alone (Abada *et al.,* 2015 and Ennab and Abo Ogiela, 2019).

The target of this investigation is the effect of exogenous application of GA_3 and CPPU on yield and fruit quality of Early Sweet grape cultivar.

MATERIALS AND METHODS

This investigation was carried out during the two consecutive seasons of (2016 and 2017) in a private vineyard located at El-Sadat City, Menoufia governorate, Egypt. The experiment was conducted on five years old Early Sweet (*vitis vinifera* L.) grape cultivar grafted on Salt Creeck rootstock. The vines were five years old, grown in a sandy soil, irrigated by the drip system, spaced at 2*3 meters apart and trellised according to the Spanish Parron system. At the first week of January during both seasons, vines were cane pruned by leaving 68 eyes/vine (12 fruiting spurs*5eyes) plus (4replacement spurs*2eyes). The cluster load was uniformly fixed to 30 clusters. All the vines were covered with blastic (120 micron thickness) before spraying with dromex until before 2 week harvesting stage for early harvesting time, which can be the most advantageous in marketing and export table grapes.

The experiment comprised eight treatments arranged in a complete randomize blocks design, each treatment was replicated three times and each replicate included one vine and the same vines were used during the two seasons of study. The selected vines received the recommended horticultural practices.

This experiment included 2 stages:-

a) **Dipping clusters with CPPU at concentrations from 1 to 7 ppm after fruit set directly.**
b) **Spraying with GA_3 at 20 ppm at 6-8mm berry diameter**

Eight treatments were applied as following:-

1- **Control (cluster dipping with tap water)**
2- **Cluster dipping with CPPU at 1 ppm + cluster spraying with GA_3 at 20 ppm**
3- **Cluster dipping with CPPU at 2 ppm + cluster spraying with GA_3 at 20 ppm**
4- **Cluster dipping with CPPU at 3 ppm + cluster spraying with GA_3 at 20 ppm**
5- **Cluster dipping with CPPU at 4 ppm + cluster spraying with GA_3 at 20 ppm**
6- **Cluster dipping with CPPU at 5 ppm + cluster spraying with GA_3 at 20 ppm**
7- **Cluster dipping with CPPU at 6 ppm + cluster spraying with GA_3 at 20 ppm**
8- **Cluster dipping with CPPU at 7 ppm + cluster spraying with GA_3 at 20 ppm**

The following parameters were measured to evaluate the tested treatments:-

1. Yield and physical characteristics of cluster

Representative random samples of three clusters/vine were harvested at maturity when TSS reached about 16-17% according to Tourky *et al.*, (1995).

Yield/vine (kg/vine) was determined as number of clusters/vine multiplied by average cluster weight (g).

- **Average cluster weight (g) was weighed by digital balance.**
- **Average cluster size (cm^3) was estimated by the volume of water displaced by immersing the cluster in a graduated jar filled with water.**

2. Physical properties of berries

- **Average berry weight (g) was weighed of fifty berries by digital balance.**
- **Average berry size (cm^3) was estimated by the volume of water displaced by immersing fifty berries in a graduated jar filled with water.**
- **Average berry dimensions (length and width) (cm) was measured by varnier caliper.**
- **Average berry shape index was estimated by dividing berry length by berry diameter.**
- **Average berry firmness (g/cm^2) was determined using magness and Tylor pressure tester.**

3. Chemical properties of berries

- **Total soluble solids (T.S.S.) percentage in berry juice was determined by hand refractometer.**
- **Total titratable acidity expressed as tartaric acid (%) was determined according to A.O.A.C. (2000).**
- **TSS /acid ratio were calculated.**

• Experimental design and statistical Analysis

The complete randomized block design was adopted for this experiment. The statistical analysis of the present data was carried out according to Snedecor and Cochran (1980). Averages were compared using the new L.S.D. values at 5% level (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

1. Yield and physical characteristics of cluster

As shown in Table (1), it was evident that the yield, cluster weight and cluster size was significantly increased by increasing the concentrations of CPPU with GA_3 at 20 ppm. Combined application of CPPU at 7 ppm plus GA_3 at 20 ppm achieved significantly the highest throughput values in comparison with the low concentrations of CPPU. On the other hand, control had the lowest values of this one in both seasons.

Highest significant cluster weight was obtained with the high concentrations of CPPU (5-7 ppm) plus GA_3 at 20 ppm in comparison with the low concentrations of CPPU (1-4 ppm) plus GA_3 at 20 ppm, while control resulted in the lowest values of this one in both seasons.

As regards cluster size, data take a parallel line concern to cluster weight. However, control and the low concentrations of CPPU (1-4 ppm) plus GA3 at 20 ppm had the lowest cluster size. On the other hand, the high concentrations of CPPU (5-7 ppm) plus GA_3 at 20 ppm had the highest values of this one.

The beneficial effects of GA_3 on the yield might be attributed to their positive action on increasing cluster weight. The promoting effects of GA_3 on the yield was supported by the results of Abu-Zahra

and Salameh (2012) on different grapevine Cvs. The results regarding the beneficial effects of Sitofex on enhancing the yield are in harmony with those obtained by Al-Obeed (2011) and Abada *et al.* (2015).

The positive action of GA_3 on cluster weight and size might be attributed to its essential role on stimulating cell division and enlargement of cells, the water absorption and the biosynthesis of proteins which will lead to increase cluster weight (Abu-Zahra and Salameh 2012). The previous essential role of CPPU on cluster weight was attributed to its higher content of cytokinin when applied to plants (Nickell, 1985). Coinciding increase in the yield of the grapevines by different GA_3 and CPPU treatments was reported earlier (Khalil, 2020).

2. Physical properties of berries

Data presented in Table (2) clarify all different tested concentrations of CPPU with GA_3 at 20 ppm improved significantly the physical properties of berries in compared with control in both seasons.

With respect berry weight, it worth mentioned that, the highest values of berry weight was obtained with the high concentrations of CPPU (5-7 ppm) plus GA_3 at 20 ppm in comparison with the low concentrations of CPPU (1-4 ppm) plus GA_3 at 20 ppm, while control resulted in the lowest values of this one in both seasons.

Table 1. Effect of some gibberellic acid and forchlorfnuron application on yield and cluster physical characteristics of Early Sweet grapes during 2016 and 2017 seasons

	Yield/ vine (kg)	Average cluster weight (g)	Average cluster size (cm3)
	2016 season		
Control (untreated vines)	10.71	357	353
CPPU at 1 ppm + GA_3 at 20 ppm	12.69	423	393
CPPU at 2 ppm + GA_3 at 20 ppm	12.96	432	398
CPPU at 3 ppm + GA_3 at 20 ppm	13.41	447	407
CPPU at 4 ppm + GA_3 at 20 ppm	13.98	466	419
CPPU at 5 ppm + GA_3 at 20 ppm	14.61	487	436
CPPU at 6 ppm + GA_3 at 20 ppm	14.76	492	442
CPPU at 7 ppm + GA_3 at 20 ppm	14.85	495	444
L.S.D at 5 %	3.77	3.8	2.9
	2017 season		
Control (untreated vines)	11.16	372	357
CPPU at 1 ppm + GA_3 at 20 ppm	13.26	442	399
CPPU at 2 ppm + GA_3 at 20 ppm	13.53	451	404
CPPU at 3 ppm + GA_3 at 20 ppm	13.95	465	412
CPPU at 4 ppm + GA_3 at 20 ppm	14.46	482	423
CPPU at 5 ppm + GA_3 at 20 ppm	15.06	502	439
CPPU at 6 ppm + GA_3 at 20 ppm	15.12	504	446

CPPU at 7 ppm + GA_3 at 20 ppm	15.15	505	449
L.S.D at 5 %	3.65	3.7	3.1

Table 2. Effect of some gibberellic acid and forchlorfnuron application on berry physical properties of Early Sweet grapes during 2016 and 2017 seasons

	Average berry weight (g)	Average berry size (cm3)	Average berry length (cm)	Average berry diameter (cm)	Average berry shape index	Average berry firmness (g/cm2)
	2016 season					
Control (untreated vines)	3.35	3.25	1.69	1.61	1.050	102.3
CPPU at 1 ppm + GA_3 at 20 ppm	4.01	3.80	1.98	1.90	1.042	116.7
CPPU at 2 ppm + GA_3 at 20 ppm	4.10	3.92	2.03	1.95	1.041	119.4
CPPU at 3 ppm + GA_3 at 20 ppm	4.25	4.08	2.11	2.03	1.039	123.1
CPPU at 4 ppm + GA_3 at 20 ppm	4.44	4.28	2.22	2.14	1.037	128.2
CPPU at 5 ppm + GA_3 at 20 ppm	4.65	4.52	2.36	2.29	1.031	135.9
CPPU at 6 ppm + GA_3 at 20 ppm	4.75	4.66	2.41	2.34	1.030	138.5
CPPU at 7 ppm + GA_3 at 20 ppm	4.81	4.72	2.42	2.36	1.025	139.6
L.S.D at 5 %	0.05	0.07	0.23	0.21	0.013	2.5
	2017 season					
Control (untreated vines)	3.53	3.34	1.70	1.62	1.049	103.7
CPPU at 1 ppm + GA_3 at 20 ppm	4.24	3.90	1.99	1.91	1.042	117.2
CPPU at 2 ppm + GA_3 at 20 ppm	4.34	4.02	2.05	1.98	1.035	119.1
CPPU at 3 ppm + GA_3 at 20 ppm	4.49	4.20	2.13	2.06	1.034	123.4
CPPU at 4 ppm + GA_3 at 20 ppm	4.67	4.44	2.23	2.16	1.032	129.5
CPPU at 5 ppm + GA_3 at 20 ppm	4.88	4.72	2.38	2.31	1.030	137.3
CPPU at 6 ppm + GA_3 at 20 ppm	4.94	4.88	2.42	2.36	1.025	140.9
CPPU at 7 ppm + GA_3 at 20 ppm	4.97	4.96	2.43	2.38	1.021	141.8
L.S.D at 5 %	0.03	0.02	0.27	0.29	0.011	2.4

Concerning berry size, data take a parallel line concern to berry weight. However, control and the low concentrations of CPPU (1-4 ppm ppm) plus GA_3 at 20 ppm had the lowest berry size. On the other hand, the high concentrations of CPPU (5-7 ppm) plus GA_3 at 20 ppm had the highest values of this one.

Highest significant berry length was obtained with the high concentrations of CPPU (5-7 ppm) plus GA3 at 20 ppm in comparison with the low concentrations of CPPU (1-4 ppm) plus GA_3 at 20 ppm, while control resulted in the lowest values of this one in both seasons.

As regards berry diameter, control and the low concentrations of CPPU (1-4 ppm) plus GA_3 at 20 ppm had the lowest cluster size. On the other hand, the high concentrations of CPPU (5-7 ppm) plus

GA_3 at 20 ppm had the highest values of this one.

With respect berry shape index, it worth mentioned that, the most round berries was obtained with the high concentrations of CPPU (5-7 ppm) plus GA_3 at 20 ppm in comparison with the low concentrations of CPPU (1-4 ppm) plus GA_3 at 20 ppm, while control resulted in the highest values of this one in both seasons.

Concerning berry firmness, control and the low concentrations of CPPU (1-4 ppm ppm) plus GA_3 at 20 ppm had the lowest berry firmness. On the other hand, the high concentrations of CPPU (5-7 ppm) plus GA_3 at 20 ppm had the highest values of this one.

The effect of GA_3 on increasing berry weight, size and dimensions might be attributed to its effect in promoting cell division and enlargement of cells, water uptake and the biosynthesis of proteins (Liu *et al.,* 2006). GA_3 is also reported to stimulate growth by promoting plasticity of the cell walls and the hydrolysis of starch into sugars that reduces the cells' water potential, inducing the entry of water into the cells and causing elongation and expansion (Richard, 2006). These results were in concordance with those obtained by Abada *et al.* (2015).

CPPU has been revealed to induce both division and elongation of cells, which increases berry size when applied after fruit set to berries (Dokoozlian, 2000). These results were in agreement with those obtained by Abu-Zahra (2013), Retamales *et al.* (2015) and Abada *et al.* (2015).

The combined treatment of GA_3 and CPPU increased the clusters and berries weight more than GA_3 or CPPU alone, suggesting the synergistic effect between cytokinin and gibberellin. This result goes in line with those of Abada *et al.* (2015), Xu *et al.* (2019) and Khalil (2020).

The increase in berries firmness by GA_3 and CPPU application could be attributed to their influence on delaying or reducing different phases of ripening. Our results concerning berry firmness are consistent with the results from the previous work on other cultivars. In this respect, Ben-Arie *et al.* (1998) found that GA_3 in combination with CPPU increased berry firmness of "Superior Seedless" grape. Also, Melillo (2005) and Avenant and Avenant (2006) found that "Red Globe" berry firmness increased when CPPU was applied at veraison stage. In addition to, Peppi and Fidelibus (2008) and Khalil (2020) reported a linear increase in "Flame Seedless" berry firmness with CPPU at various concentrations.

3. Chemical properties of berries

As shown in Table (3), data revealed that berry chemical properties expressed TSS, acidity and TSS/acid ratio of Early Sweet grape cultivar are significantly by different tested concentrations of CPPU plus GA_3 at 20 ppm in compared with control in both seasons.

Lowest significant TSS percentage was occurred from the high concentrations of CPPU (5-7 ppm) plus GA_3 at 20 ppm in comparison with the low concentrations of CPPU (1-4 ppm) plus GA_3 at 20 ppm, while control resulted in the highest percentages of this one in both seasons.

As regards acidity, control and the low concentrations of CPPU (1-4 ppm) plus GA_3 at 20 ppm had the lowest percentage of acidity. On the other hand, the high concentrations of CPPU (5-7 ppm) plus GA_3 at 20 ppm had the highest percentages of this one.

With respect TSS/acid ratio, it worth mentioned that, the lowest values of TSS/acid ratio was obtained with the high concentrations of CPPU (5-7 ppm) plus GA_3 at 20 ppm in comparison with the low concentrations of CPPU (1-4 ppm) plus GA_3 at 20 ppm, while control resulted in the highest values of this one in both seasons.

Table 3. Effect of some gibberellic acid and forchlorfnuron application on berry chemical properties of Early Sweet grapes during 2016 and 2017 seasons.

	TSS (%)	Total acidity (%)	TSS/acid ratio
	2016 season		
Control (untreated vines)	17.6	0.34	51.8
CPPU at 1 ppm + GA_3 at 20 ppm	15.4	0.52	29.6
CPPU at 2 ppm + GA_3 at 20 ppm	15.1	0.57	26.5
CPPU at 3 ppm + GA_3 at 20 ppm	14.7	0.61	24.1
CPPU at 4 ppm + GA_3 at 20 ppm	14.3	0.64	22.3
CPPU at 5 ppm + GA_3 at 20 ppm	14.0	0.67	20.9
CPPU at 6 ppm + GA_3 at 20 ppm	13.5	0.71	19.0
CPPU at 7 ppm + GA_3 at 20 ppm	13.0	0.79	16.5
L.S.D at 5 %	0.20	0.02	8.7
	2017 season		
Control (untreated vines)	18.0	0.33	54.5
CPPU at 1 ppm + GA_3 at 20 ppm	15.8	0.55	28.7
CPPU at 2 ppm + GA_3 at 20 ppm	15.5	0.60	25.8
CPPU at 3 ppm + GA_3 at 20 ppm	15.1	0.63	24.0
CPPU at 4 ppm + GA_3 at 20 ppm	14.5	0.67	21.6
CPPU at 5 ppm + GA_3 at 20 ppm	14.1	0.72	19.6
CPPU at 6 ppm + GA_3 at 20 ppm	13.4	0.79	17.0
CPPU at 7 ppm + GA_3 at 20 ppm	12.7	0.82	15.5
L.S.D at 5 %	0.21	0.03	7.4

The increase in the keeping quality of the berries obtained in the current study might be interpreted by the positive influence of the GA_3 and CPPU in increasing fruit firmness, reducing TSS and delaying berry maturation (Ben-Arie *et al.,* 1998, Tumminelli *et al.,* 2005, Zabadal & Bukovac 2006, Samara *et al.,* 2007, Abada *et al.,* 2015 and Khalil 2020).

CONCLUSION

Excessive CPPU doses + spraying GA_3 increases yield and physical properties of berries i.e. berry weight, size and firmness, but it delay maturation. In contrast, lower CPPU doses + spraying GA_3 cause a slightly in retarding maturation but reduces yield and its components. On the other hand, moderate CPPU doses (dipping clusters with CPPU at 5 ppm + spraying clusters with GA_3 at 20 ppm) had an achieving in

appropriate balance between yield and cluster quality attributes of Early Sweet grapevines in both seasons.

Finally, we conclude that the quality of Early Sweet grapes could be easily improved by the considered treatments. We recommend the combined dipping clusters with CPPU at 5 ppm + spraying clusters with GA_3 at 20 ppm for its' better effect on yield and fruit quality attributes. Yet, further investigations should be carried in this proposed protocol for decreasing the delay of berry maturation.

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تأثير بعض معاملات الجبريليك و السيتوفكس علي إنتاجية و نمو حبات العنب صنف الإيرلى سويت

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الملخص العربى

أجريت هذه الدراسة خلال الموسمين المتتاليين (2016 و 2017) في مزرعة خاصة تقع في مدينة السادات بمحافظة المنوفية لدراسة تأثير بعض معاملات حامض الجبريليك والسيتوفكس على الإنتاجية ونمو حبات العنب صنف الإيرلى سويت. كانت الكرمات عمرها خمس سنوات، متباعدة على مسافة 2 × 3 أمتار ، نامية في تربة رملية، ومرباة تحت نظام التدعيم التكاعيب الإسبانية.

تم إجراء ثمانية معاملات من خلال استخدام تغطيس العناقيد بالسيتوفكس بتركيزات من 1 إلى 7 جزء في المليون بعد عقد الثمار مباشرة بالإضافة إلى الرش بحامض الجبريليك بتركيز20 جزء في المليون عندما تصل قطر الحبات من 6-8 مم بالإضافة إلى معاملة الكنترول. أظهرت النتائج أن جميع معاملات حامض الجبريليك والسيتوفكس أعطت أفضل النتائج مقارنة بمعاملة الكنترول في كلا الموسمين. كما أن التركيزات الزائدة من السيتوفكس + رش العناقيد بحامض الجبريليك أدت إلى زيادة المحصول وتحسين الصفات الطبيعية للحبات مثل وزن وحجم وصلابة الحبات، إلا أنها أدت إلى تأخير النضج. على العكس من ذلك ، فإن تركيزات السيتوفكس المنخفضة + رش العناقيد بحامض الجبريليك تسبب تأخرًا طفيفًا في النضج ولكنها قللت المحصول ومكوناته. من ناحية أخرى ، فإن جرعات السيتوفكس المعتدلة (غمس العناقيد بالسيتوفكس عند 5 جزء في المليون + رش العناقيد بحامض الجبريليك عند 20 جزء في المليون) حققت توازنًا مناسبًا بين خصائص المحصول وصفات جودة الحبات للعنب صنف الإيرلى سويت في كلا الموسمين.

الكلمات الدالة: عنب، الإيرلى سويت، حامض الجبريليك، السيتوفكس، عنقود، إنتاجية، حبات، جودة، صفات.

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