Journal of Plant Production

Journal homepage & Available online at: www.jpp.journals.ekb.eg

Improving Yield and Bunches Quality of Sultana 'H4 strain' Grapevines

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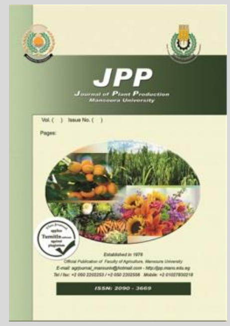

ABSTRACT

This study was carried out during the seasons of 2021-2022 to study the effect of GA_3 plus urea each alone or with trunk girdling and bunches tipping on yield and bunch quality of Sultana 'H4 strain' grapevines. The data reveal that spraying vines with GA_3 plus urea at the beginning of (15-20%) flowering significantly reduced the number of berries per bunch and the compactness coefficient of the bunch than the control. Furthermore, sprayed vines with GA_3 plus urea with both trunk girdling and bunches tipping significantly produced a higher bunch weight, berry weight, and size. Despite this, treated bunches with GA_3 plus urea gave no clear effect of SSC/acid ratio in berry juice than the control but increased the values of total chlorophyll a and b content in berry skin. Whereas, when girdling the trunk and tipping the bunch produced a higher SSC/acid ratio in berry juice and total carotenoid content in berry skin than the control.

Keywords: Sultana 'H4 strain'; Gibberellic Acid (GA_3); Urea; Girdling; Bunches Tipping

INTRODUCTION

Grapes (*Vitis vinifera* L.) are one of the most important and widely cultivated fruit crops in Egypt. Since it ranks second after citrus in terms of cultivated area in Egypt. The total cultivated area reached about 172,533.6 feddans in Egypt with an annual total production of about 1,586,342 tons (FAO, 2020). Recently there are many new varieties were planted in Egypt, which have found some problems that threaten their production and the continuation of their cultivation.

One of the most important grape cultivars introduced for cultivation in Egypt is the Sultana 'H4 strain' grapevines, it is considered seedless cultivar with vigorous growth, yellow-green, and small to medium berries, clusters are large, conical, and compact (Hannah *et al.,* 2002). Sultana H4 is a strain of Sultana grapes that spread recently in Egypt and the expansion of its cultivation increased due to the higher production, in addition to its higher fertility rate than Thomson Seedless grapes. Sultana 'H4 strain' cultivar become one of the most important table grapes in local markets. Yet, high compactness of bunches and small size of berries are the most problem facing this cultivar and this leads to a high percentage of moisture between berries and some of them in bunches as a result bunches become infected with fruit rot and thus this can cause a major loss in production and quality (Rashad *et al.,* 2021).

Plant growth substances play a major role in growth and development. Since grapevines are sprayed with GA_3 and urea at the flowering stage to enhance bunch thinning and berry size in seedless cultivars (Nampila *et al.,* 2010). In this respect, gibberellic acid (GA_3) application promotes cell division and cell enlargement as well as increases the biosynthesis of proteins and producing new tissues promoting the water and nutrients absorption which will lead to increased bunch length as well as, berry size and weight (Dimovska *et al.,* 2011 and Dimovska *et al.,* 2014). Whereas, the previous studies presented that, GA_3 decreased bunch compactness and let to improve berries quality (Koukourikou *et al.,* 2015 and Senthilkumar *et al.,* 2018).

The effect of gibberellic acid depends on the variety, concentration, and time of application (Casanova *et al.,* 2009). Since gibberellic acid is used at bloom and full bloom stage on Thompson and Flame Seedless to reduce berry set. Whereas, treated vines at 10-14 days after blooming increased berry weight and size of the remaining berries (Khan *et al.,* 2009 and Dimovska *et al.,* 2011).

Recently, the application of GA_3 along with chemical treatments such as urea is used for several grape cultivars. This practice has a major role to reduce bunch compactness and enhancing yield and berry quality (Mohsen and Ali, 2019). According to (Dokoozlian and Peacock, 2001; Casanova *et al.,* 2009 and Mohsen, 2015), urea spraying at pre-bloom or at full bloom led to a reduction of the berry set and consequently induces berry thinning.

Also, girdling has been a major practice to increase berry weight and advance fruit maturity (Weaver, 1955 and Zabadal, 1992). Since girdling is used at berry set to increase bunch weight and berry size (Abu-Zahra, 2010).This increment in berry size due to girdling may be due to their effect on increasing total carbohydrates in the trunk and the cane above the girdle as the transport of sugars from leaves to the root system is effectively blocked (Roper and Williams, 1989). Bunches tipping after fruit set has been used to promote berry size, yield, and enhanced bunch quality for different grapes cultivars (El-Fattah *et al.,* 2009).

This study aimed to evaluate the effect of using GA_3 with urea each alone or with trunk girdling and bunches tipping each alone or in combination on berry thinning, bunches compactness, berry quality, and yield of Sultana 'H4 strain' grapevines.

MATERIALS AND METHODS

This study was carried out during the seasons of 2021-2022 in the vineyard of experiential field Horticulture Research Institute, Mansoura, Dakahlia Governorate, Egypt on seven years old Sultana 'H4 strain' grapevines grafted on freedom rootstock. The vines were grown in clay soil under a surface irrigation system, vines were planted at 2 x 3 meters using cane pruning by leaving 10 canes each of 12 eyes with 6 spurs each of 2 eyes, the total bud load was about 132 buds

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DOI: 10.21608/jpp.2022.157868.1159

per each vine, under the Spanish Parron trellising system.

From this study, thirty-six vines uniform in vigor as much as possible were chosen, and all vines received the same cultural management recommended by the ministry of agriculture. The experiment involved six treatments each one represented with 6 vines as follows:

1- Control spraying with water
2- GA_3 at 15 ppm + urea at 0.5%
3- GA_3 at 15 ppm + urea at 0.5% + bunches tipping at length of 18 cm
4- GA_3 at 15 ppm + urea at 0.5% + girdling
5- GA_3 at 15 ppm + urea at 0.5% + girdling + bunches tipping at length of 18 cm
6- GA_3 at 15 ppm + urea at 0.5% + bunches tipping at 18 cm + GA_3 at 30 ppm

Gibberellic acid (GA_3) was sprayed at 15 ppm with urea at 0.5% three times, one at beginning of (15-20%) bloom, and twice each one after three days later. Whereas GA_3 was sprayed at 30 ppm twice, one when berry size reached about 7-8 mm and the second four days later. In addition, after the fruit set bunches tipping at length of 18 cm was carried out and the trunks were girdled above 100 cm of the soil.

At harvest time, when the soluble solids content reached about 16-18% in berry juice samples of bunches for each replicate were taken to Pomology Laboratory Research, Faculty of Agriculture, Mansoura University, Egypt for physical and chemical analysis.

In both growing seasons, four bunches per vine were weighed and the yield per vine (kg) was estimated by multiplying the average bunch weight (g) by the number of bunches per vine. Yield per feddan was calculated by multiplying yield/vine by the number of vines/feddan (700 vines) and the results were estimated as a ton.

Physical and chemical analysis of bunches and berries: samples of four bunches per vine were taken at harvest time for the following measurements: Average bunch weight (g) and the number of berries per bunch. While the coefficient of bunch compactness was calculated by dividing the number of bunch berries by bunch length (Belal, 2019), as well as average berry weight (g) and berry size (mm) were also estimated.

Soluble solids content (SSC): soluble solids content in berry juice was measured by using a hand refractometer according to (Chen and Mellenthin, 1981).

Total acidity (TA): 5 mL of berry juice were taken for titration with 0.1 N sodium hydroxide (NaOH) to a phenolphthalein endpoint using a color indicator and expressed as a percentage of tartaric acid according to (AOAC, 2005). Also, SSC/acid ratio was calculated by dividing the percentage of SSC by total acidity.

Photosynthetic pigments: total chlorophylls a, b, and total carotenoid content of berry skin were determined by the methods described according to (Lichtenthaler and Wellburn, 1985) with a minor modification. Half gram of fresh skin berries was taken for each 10 mL methanol and put in the refrigerator for 48 hours and the results were expressed as (mg/100g for FW).

Statistical analysis:

Data from both seasons of the study were statistically analyzed by using a complete randomized block design. All treatments were performed in triplicates and repeated three times. Statistical analysis was performed by one-way analysis of variance and analyzed further by Duncan's multiple range test at $p < 0.05$ probability (Duncan, 1955). The data were analyzed using the CoStat software package (CoStat, 1991).

RESULTS AND DISCUSSION

The results presented the effect of spraying GA_3, urea each alone or with tipping the bunches or girdling the trunk on yield and bunches quality of Sultana 'H4 strain' grapevines are shown as follows:

Effect on yield per vine and per feddan:

It's clear from Table 1 that all treatments used reduced average yield per vine and per feddan than the control during both seasons in this study. This is attributed due to GA_3 application at full bloom decreased berry set and increased flower dropping, causing a reduction of berries number of clusters. The reduced in yield per vine and per feddan achieved by bunch thinning has been also reported (Knezović *et al.,* 2009). As well as, the positive action of urea as a nitrogen source and producing new tissues that enhance the water and nutrients absorption induce more vegetative growth that shifted the balance of competition between reproductive growth and vegetative organs in favor of the latter (El-Fattah *et al.,* 2009). The results are in line with those obtained by several research workers such as (Dokoozlian and Peacock, 2001; El-Akkad, 2004; Ahmed, 2007 and Selim, 2007). They revealed that sprayed vines with GA_3 at full bloom in different grapevine cultivars gave a good thinning effect since it decreased the berry set percentage compared to control.

Whereas vines sprayed with GA_3 at 15 ppm + urea at 0.5% at the flowering stage with girdling the trunk after fruit set significantly increased average yield per vine and per feddan than other treatments used during both seasons. The increment in yield/vine due to girdling application could be attributed to increasing both berry weight and size.

Table 1. Effect of GA_3, urea, and some cultural practices on average yield per vine and per feddan of Sultana 'H4 strain' grapevines.

Treatments	Av. Yield/vine (Kg)		Mean	Av. Yield/feddan (ton)		Mean
	2021	2022		2021	2021	
Control	12.1^b	21.9^b	17.0	8.4^b	15.3^b	11.9
GA_3 at 15 ppm + urea at 0.5%	11.0^c	20.8^b	15.9	7.7^c	14.6^b	11.2
GA_3 at 15 ppm + urea at 0.5% + tipping*	8.1^f	15.3^d	11.7	5.7^f	10.7^d	8.2
GA_3 at 15 ppm + urea at 0.5% + girdling*	13.3^a	25.2^a	19.3	9.3^a	17.6^a	13.5
GA_3 at 15 ppm+ urea at 0.5% + girdling* + tipping*	8.8^e	16.2^{cd}	12.5	6.2^e	11.3^{cd}	8.8
GA_3 at 15 ppm + urea at 0.5% + tipping* + GA_3 at 30 ppm	9.3^d	17.1^c	13.2	6.5^d	12.0^c	9.2

Note: 1-GA_3 at 15 ppm and urea at 0.5% were sprayed at the initial of (15-20%) flowering.
2-* Tipping of bunches at length of 18 cm and girdling were carried after fruit set.
3- GA_3 at 30 ppm was sprayed when berry size reached about 7-8 mm.

So, girdling grapevines increases carbohydrate concentration above the girdle and resulted in larger berries as the transport of sugars from leaves to the root system is effectively blocked (Roper and Williams, 1989). Moreover, the increment in yield per vine and per feddan may be due to that GA_3 increases cell division and cell enlargement as well as elevating the biosynthesis of proteins and producing new tissues that improve the water and nutrients absorption which is consequently, reflected in increasing the bunch length, as well as, berry size and weight and bunch weight, thus increasing the yield (Dimovska *et al.,* 2011; Abu-Zahra and Salameh, 2012 and Dimovska *et al.,* 2014).

On other hand, vines sprayed with GA_3 at 15 ppm + urea and girdling the trunk with bunches tipping gave a lower yield per vine than those treated with GA_3 at 30 ppm plus urea with bunches tipping this was due to GA_3 at anthesis increased berry size due to the increase in sink strength for accumulating nutrients such as K (Zhenming *et al.,* 2008).

Effect on bunch weight, number of berries per bunches, and compactness coefficient:

Regarding the effect on average bunch weight, data from Table 2 showed that all treatments used significantly reduced average bunch weight than the control except the vines which were treated with GA_3 + urea + girdling in the first season. Since this treatment produced a higher bunch weight than the other treatments used. So, the increment due to this treatment was about 12.7% more than the control as a mean of two seasons. Whereas vines treated with bunches tipping at 18 cm after fruit set gave a lower bunch weight than those left without tipping or the control. Whereas sprayed vines with GA_3 at 15 ppm + urea at 0.5% plus bunches tipping after fruit set gave a lower bunch weight than the other treatments used in both seasons of study. Since the reduction in average bunches weight due to this treatment was 31.5% less than the control as means of two seasons. On the other hand, vines treated with GA_3 at 15 ppm + urea with bunches tipping and sprayed with GA_3 at 30 ppm after fruit set increased average bunch weight than vines treated with GA_3 + urea + bunches tipping and girdling. The increase in the weight of bunches was due to girdling and GA_3 sprays were used together as they have a synergistic effect on increasing the berry size (Brar *et al.,* 2008).

According to previous studies (Harrell and Williams, 1987; Roper and Williams, 1989; Brar *et al.,* 2008; Zhenming *et al.,* 2008 and El-Fattah *et al.,* 2009) mentioned that the uses of GA_3 at anthesis were found to increase berry size due to increased sink strength for accumulating nutrients. Also girdling grapevines increases carbohydrate concentration above the girdle and resulted in larger berries as the transport of sugars from leaves to the root system is effectively blocked.

Data from Table 2 also showed that all treatments used significantly reduced the number of berries per bunch and average bunch compactness coefficient than the control during both seasons under study. These results are in harmony with those findings of the use of GA_3 sprayed at the anthesis stage which reduced the number of flowers than the control (Dokoozlian and Peacock, 2001; Selim, 2007; El-Fattah *et al.,* 2009 and Abu-Zahra, 2010). Furthermore, the data also reveal that all tipping practices significantly produced a lower number of berries per bunch than those left without tipping or the control. Since tipping applications produced a lower berry number of the bunch by about over 50% less than the control. Concerning the average bunch compactness coefficient, data in the same table showed that all treatments used significantly reduced bunch compactness than the control during both seasons.

Moreover, vines sprayed with GA_3 at 15 ppm + urea each alone or with girdling gave a higher berry number per bunch than the other treatments used but less than the untreated one. This increment may be due to the remarkable influence on the accumulation of organic food materials above the girdle until after healing. The positive action of GA_3 on stimulating the cell elongation process enhances the water absorption and stimulates the biosynthesis of proteins which will lead to an increase in the cluster length, as well as berry size and weight. Spraying vines with GA_3 + urea either alone or with girdling and bunches tipping was more effective in improving the cluster traits, since decreasing the berries number consequently significantly decreased the compactness coefficient (El-Fattah *et al.,* 2009; Abu-Zahra, 2010 and Koukourikou *et al.,* 2015). These results nearly are in agreement with that obtained by (Roper and Williams, 1989) who found that sprayed GA_3 at anthesis reduced the number of flowers that set. Spraying vines with GA_3 induces competition for nutrients between shoots and flowers or among flowers within the same bunch. It means flower thinning is caused due to a decrease in the available amount of nutrients for flowers' growth and development. Also, GA_3 increases the transfer rate of nutrients to the sprayed plant organs (Gil *et al.,* 1994). In addition, the positive action of urea as a nitrogen source and producing new tissues that water and nutrients absorption induce more vegetative growth that shifted the balance of competition between reproductive growth and vegetative organs in favor of the latter (El-Halaby *et al.,* 2015).

Table 2. Effect of GA_3, urea, and some cultural practices on average bunch weight, number of berries per bunch, and compactness coefficient of Sultana 'H4 strain' grapevines.

Treatments	Av. bunch weight (g)		Mean	Av. berries number/bunch		Mean	Av. bunch compactness coefficient		Mean
	2021	2022		2021	2022		2021	2022	
Control	755.0[b]	729.3[b]	742.2	392.7[a]	319.5[a]	356.1	15.6[a]	12.1[a]	13.9
GA_3 at 15 ppm + urea at 0.5%	689.3[c]	694.9[b]	692.1	258.9[c]	260.8[b]	259.9	9.8[bc]	9.8[b]	9.8
GA_3 at 15 ppm + urea at 0.5% + tipping*	507.3[f]	509.0[d]	508.2	176.4[d]	175.5[c]	176.0	9.8[bc]	9.8[b]	9.8
GA_3 at 15 ppm + urea at 0.5% + girdling*	833.3[a]	839.2[a]	836.3	275.0[b]	270.7[b]	272.9	10.8[b]	10.0[b]	10.4
GA_3 at 15 ppm+ urea at 0.5% + girdling* + tipping*	551.7[e]	539.5[cd]	545.6	175.0[d]	174.1[c]	174.5	9.7[c]	9.7[b]	9.7
GA_3 at 15 ppm + urea at 0.5% + tipping* + GA_3 at 30 ppm	579.7[d]	569.5[c]	574.6	173.4[d]	172.6[c]	173.0	9.7[c]	9.6[b]	9.6

Note: 1- GA_3 at 15 ppm and urea at 0.5% were sprayed at the initial of (15-20%) flowering.
2- * Tipping of bunches at length of 18 cm and girdling were carried after fruit set.
3-GA_3 at 30 ppm was sprayed when berry size reached about 7-8 mm.

Nitrogen has many functions in all divisions, including the synthesis of proteins, protoplasm, enzymes, and organic compounds such as nucleoproteins, amino acids, and chlorophyll (Nijjar, 1985). On the other hand, GA_3 + urea application either in single or in a combination with girdling or bunches tipping reduced the compactness of bunches compared to the control, because it plays a very important role in berries thinning. So, this application produced a bunch with less compactness and with high quality.

Effect on average berry weight and size:

Data from Table 3 reveal that all treatments used significantly increase both berry weight and size than the control. Furthermore, vines sprayed with GA_3 at 15 ppm + urea and tipping its bunch and girdling the trunk after fruit set gave a higher berry weight and size than the other treatments used. The increment because of this treatment may be due to the effect of tipping on reducing the number of berries per bunch which produced a higher berry weight than those without tipping. Likewise, vines sprayed with GA_3 at 30 ppm when the berry size reached 7-8 mm also gave a higher berry weight and size than the other treatments or the control. Since this application has a more pronounced effect on increasing berry weight and size. These results showed that vines in which girdled and sprayed with GA_3 together have a synergistic effect on increasing the berry size (Brar *et al.,* 2008).

Table 3. Effect of GA_3, urea, and some cultural practices on average berry weight and size of Sultana 'H4 strain' grapevines.

Treatments	Av. berry weight (g)		Mean	Av. berry size (mm)		Mean
	2021	2022		2021	2021	
Control	1.9^{f}	1.9^{e}	1.9	13.6^{d}	14.3^{c}	13.9
GA_3 at 15 ppm + urea at 0.5%	2.7^{e}	2.7^{d}	2.7	16.0^{c}	16.3^{b}	16.2
GA_3 at 15 ppm + urea at 0.5% + tipping*	2.9^{d}	2.9^{c}	2.9	16.3^{bc}	16.7^{a}	16.5
GA_3 at 15 ppm + urea at 0.5% + girdling*	3.0^{c}	3.1^{b}	3.1	16.3^{bc}	16.8^{a}	16.6
GA_3 at 15 ppm+ urea at 0.5% + girdling* + tipping*	3.2^{b}	3.1^{b}	3.1	17.0^{b}	16.8^{a}	16.9
GA_3 at 15 ppm + urea at 0.5% + tipping* + GA_3 at 30 ppm	3.4^{a}	3.3^{a}	3.3	18.0^{a}	16.9^{a}	17.5

Note: 1-GA_3 at 15 ppm and urea at 0.5% were sprayed at the initial of (15-20%) flowering.

2-* Tipping of bunches at length of 18 cm and girdling were carried after fruit set.

2- GA_3 at 30 ppm was sprayed when berry size reached about 7-8 mm.

Furthermore, the direct effect of GA_3 on stimulating cell division and enlargement, and increasing fruit size was previously indicated by (Fraga *et al.,* 2004 and Liu *et al.,* 2006). Previous studies with (Brar *et al.,* 2008; Guo *et al.,* 2012; Ren *et al.,* 2013 and Tyagi *et al.,* 2020), indicated that girdling vines increased berry size because more photosynthate was transported to the berry, stimulating the accumulation of more water and expansion of berry size.

Effect on soluble solids content (SSC), total acidity, and SSC/acid ratio:

Data presented in Table 4 showed that all treatments used gave no clear effect on SSC in berries juice of Sultana 'H4 strain'. These results are in agreement with (Dimovska *et al.,* 2014) who reported that sprayed GA_3 at 20 ppm on flame seedless grapes had no significant influence on SSC and total acidity compared to the control. Whereas vines sprayed with GA_3 at 30 ppm after fruit set gave a lower SSC in berries juice than the other treatments used. These results are in agreement with (Wassel *et al.,* 2007) who found that vines sprayed with GA_3 at 25 or 50 ppm on white 'Banaty' seedless grapevines significantly reduced each SSC and the ratio between SSC/acid. Likewise, the application of GA_3 at 40 ppm twice (20% of open flowers and full bloom) significantly decreased the SSC of 'Superior Seedless' grapevines compared to the control (Abu-Zahra, 2013).

Regarding the effect on total acidity in berry juice, data reveal that all treatments used gave no clear effect on total acidity during both seasons under this study. Whereas vines treated with GA_3 + urea + girdling gave the lowest total acidity in berries juice than the other treatments except for the control in the first season.

Yet, vines sprayed with GA_3 + urea at the beginning of flowering with tipping the bunches and sprayed with GA_3 at 30 ppm after fruit set gave a higher significant value of total acidity in berry juice than the other treatments used or the control. These results are in agreement with (Nilnond *et al.,* 2010).

Concerning the effect on SSC/acid ratio, the data in the same table showed that vines sprayed with GA_3 + urea with girdling the trunk produced higher values of SSC/acid ratio than the other treatments used except for the control in both seasons of study. That may be due to girdling producing a lower value of total acidity. Whereas sprayed vines with GA_3 at 30 ppm after fruit set significantly produced lower values of SSC/acid ratio than other treatments or the control. So, this treatment produced a lower value of SSC with a higher content of total acidity in berry juice than the other treatments used. These results are in agreement with (El-Akad *et al.,* 2021) who cleared that sprayed grapevines with GA_3 at 20 ppm after the berry set gave the lowest SSC, SSC/acid ratio, and highest total acidity compared to the control.

Table 4. Effect of GA_3, urea, and some cultural practices on soluble solids content (SSC), total acidity, and SSC/acid ratio of Sultana 'H4 strain' grapevines.

Treatments	SSC (%)		Mean	Total acidity (%)		Mean	SSC/acid ratio		Mean
	2021	2022		2021	2022		2021	2022	
Control	18.5^{a}	18.4^{a}	18.5	0.6^{d}	0.8^{c}	0.7	29.1^{a}	24.2^{a}	26.7
GA_3 at 15 ppm + urea at 0.5%	18.1^{ab}	17.8^{bc}	17.9	0.7^{b}	0.8^{c}	0.7	28.3^{a}	22.9^{b}	25.6
GA_3 at 15 ppm + urea at 0.5% + tipping*	18.0^{b}	17.6^{bc}	17.8	0.8^{b}	0.9^{b}	0.8	23.2^{b}	20.7^{c}	22.0
GA_3 at 15 ppm + urea at 0.5% + girdling*	18.4^{ab}	18.1^{ab}	18.2	0.6^{d}	0.8^{c}	0.7	28.7^{a}	23.3^{ab}	26.0
GA_3 at 15 ppm+ urea at 0.5% + girdling* + tipping*	18.0^{b}	17.5^{bc}	17.7	0.8^{b}	0.8^{b}	0.8	23.8^{b}	21.2^{c}	22.5
GA_3 at 15 ppm + urea at 0.5% + tipping* + GA_3 at 30 ppm	17.9^{b}	17.3^{c}	17.6	0.8^{a}	0.9^{a}	0.9	21.5^{c}	19.2^{d}	20.4

Note: 1-GA_3 at 15 ppm and urea at 0.5% were sprayed at the initial of (15-20%) flowering.

1- * Tipping of bunches at length of 18 cm and girdling were carried after fruit set.

2- GA_3 at 30 ppm was sprayed when berry size reached about 7-8 mm.

Effect on chlorophyll a, b, and total carotenoid content:

The data in Table 5 showed that treated vines with GA_3 + urea at the beginning of the flowering stage with bunches tipping and sprayed bunch's with GA_3 at 30 ppm after the berry set of Sultana 'H4 strain' grapevines gave higher values of chlorophyll a and b content followed by GA_3 + urea either alone or in combination with bunches tipping or girdling. On the other hand, the untreated berries produced the lowest values of chlorophyll a and b content. These results are in agreement with (Salehi *et al.,* 2014).

Regarding the effect of total carotenoid content on berry's skin, data in Table 5 revealed that vines treated with GA_3 + urea + tipping produced higher significant values of total carotenoid content in both seasons of the study compared with all treatments. Furthermore, vines treated with GA_3 + urea + girdling gave a similar effect on total carotenoid content than those treated with GA_3 + urea or the control. On the other hand, vines sprayed with GA_3 at 30 ppm after berry set with girdling plus tipping gave lower values of carotenoid content but, also presented higher values of chlorophyll a and b content. These results are in harmony with (Suehiro *et al.,* 2019) who found that in 'Shine Muscat' berry skin, chlorophyll was less decomposed following GA_3 or Cytokinin treatment; thus, skin color remained greenish during the maturation stage.

Table 5. Effect of GA_3, urea, and some cultural practices on chlorophyll a, b, and total carotenoid content on berry skin of Sultana 'H4 strain' grapevines.

Treatments	Chlorophyll a (mg/ 100 g FW)		Mean	Chlorophyll b (mg/ 100 g FW)		Mean	Carotenoid content (mg/ 100 g FW)		Mean
	2021	2022		2021	2022		2021	2022	
Control	1.69[d]	1.74[e]	1.72	0.695[e]	0.696[e]	0.696	0.882[d]	0.885[d]	0.884
GA_3 at 15 ppm + urea at 0.5%	1.98[b]	2.04[b]	2.01	0.866[b]	0.882[b]	0.874	0.795[e]	0.795[e]	0.795
GA_3 at 15 ppm + urea at 0.5% + tipping*	1.92[b]	1.97[c]	1.95	0.817[c]	0.818[c]	0.818	0.991[a]	0.993[a]	0.992
GA_3 at 15 ppm + urea at 0.5% + girdling*	1.84[c]	1.89[d]	1.87	0.760[d]	0.762[d]	0.761	0.953[b]	0.957[b]	0.955
GA_3 at 15 ppm+ urea at 0.5% + girdling* + tipping*	1.91[b]	1.96[c]	1.94	0.755[d]	0.757[d]	0.756	0.894[c]	0.896[c]	0.895
GA_3 at 15 ppm + urea at 0.5% + tipping* + GA_3 at 30 ppm	2.21[a]	2.25[a]	2.23	0.942[a]	0.947[a]	0.945	0.790[e]	0.793[e]	0.792

Note: 1-GA_3 at 15 ppm and urea at 0.5% were sprayed at the initial of (15-20%) flowering.
1- * Tipping of bunches at length of 18 cm and girdling were carried after fruit set.
2- GA_3 at 30 ppm was sprayed when berry size reached about 7-8 mm.

CONCLUSION

From the above-mentioned results, the data presented that treated Sultana 'H4 strain' grapevines with GA_3 plus urea at the beginning of flowering reduced the number of berries per bunch and compactness coefficient than the control. Furthermore, vines sprayed with GA_3 at 15 ppm + urea at 0.5% at the flowering stage with girdling the trunk after fruit set significantly increased average yield per vine and per feddan than other treatments used. This increment may be due to an increase in average bunch weight and the number of berries per bunch. Furthermore, sprayed vines with GA_3 plus urea with girdling the trunk significantly produced a higher average bunch weight. on the other hand, treated vines with GA_3 plus urea with tipping the bunch and sprayed with GA_3 at 30 ppm after the berry set gave higher values of berry weight, and size and lower values of SSC, SSC/acid ratio, and total carotenoid content, but gave a higher value of total acidity, chlorophyll a and b than the other treatments.

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تحسين المحصول وجودة عناقيد العنب صنف سلطانة 'سلالة H4'

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الملخص

أجريت هذه الدراسة خلال موسمي 2021-2022 وذلك لدراسة تأثير الرش بحمض الجبريليك بتركيز ١٥ جزء في المليون مع اليوريا بتركيز 0.5% عند بداية التزهير وكذا بعد ثلاثة أيام من الرشة الاولى ثم تكرار الرش للمرة الثالثة بعد ثلاثة أيام من المرة الثانية منفرداً أو مع إجراء تحليق الجذع على إرتفاع ١٠٠ سم من سطح التربة وكذا تقصير العناقيد بطول ١٨ سم بعد العقد وأثر ذلك على المحصول وصفات وجودة عناقيد وحبات العنب صنف سلطانة 'سلالة H4'. ولقد أوضحت النتائج أن رش الكرمات بأستخدام حمض الجبريليك مع اليوريا في بداية الإزهار أدى إلى خفض عدد الحبات في العنقود وكذا معامل تزاحم الحبات بالعناقيد مقارنة بالكنترول. علاوة على ذلك أدى رش الكرمات بأستخدام حمض الجبريليك مع اليوريا مع تحليق الجذع وكذا تقصير العناقيد إلى زيادة وزن وحجم الحبات. هذا ولم تظهر الدراسة أن رش العناقيد بحمض الجبريليك مع اليوريا أي تأثير واضح ومؤكد على نسبة المواد الصلبة الذائبة الكلية إلى الحموضة في عصير الحبات بالمقارنة بالكنترول بينما زادت من قيم محتوى الكلوروفيل الكلي (أ ، ب) في قشرة الحبات. في حين أظهر إجراء تحليق الجذع وتقصير العناقيد ، زيادة في نسبة المواد الصلبة الذائبة الكلية إلى الحموضة في عصير الحبات وكذا محتوى قشرة الحبات من الكاروتينات الكلية عن باقي المعاملات.