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RESEARCH ARTICLE

Effect of berry thinning and sitofex on fruiting of Superior Seedless grapevines

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Abstract

The effect of berry thinning and GA_3 plus CPPU applied on productivity of Superior Seedless grapevines during 2020, 2021 and 2022 seasons were studied. All grapevines were 14 years old and grown at the experimental orchard Faculty of Agriculture, South Valley University, Qena Governorate. Berry thinning was performed after berry set; whereas CPPU was applied when berry at pea stage. The experiment was set up as randomized complete block design (RCBD) with three replicates, two vines per each.

The obtained results could be summarized as follow

Berry thinning as removing either 25% of apical cluster or 25% of shoulders significant decrease the berries number per cluster and consequently insignificantly decreased the cluster weight and yield/vine compared to untreated one. Such berry thinning methods significantly increased berry weight and the chemical constituents of juice compared to untreated ones. In addition, all treatments except removing 25% of apical cluster significantly decreased shot berries % and the compactness coefficient of clusters. GA_3 plus CPPU dipping significantly increased the berry weight and consequently significantly increased the cluster weight and yield/vine as well as improved the berry chemical quality compared to untreated one (control). From this study, it is clear that to improve cluster and berries quality we can make berry thinning as alternatively about 25% of shoulders or combined GA_3 at 20 ppm plus, CPPU at 1.5 ppm dipping.

Keywords: Berry thinning; CPPU; GA3; Superior Seedless; Quality.

1. Introduction

The grape is considered as one of the most important fruit crops in the world, for being of an excellent flavor, nice taste and high nutritional value. It is the third fruit crop in Egypt after mangoes and citrus. The cultivated area has grown rapidly in the last two decades reaching 221709 feddans with annual production of 1676259 tons (According to the M.A.L.R. 2019).

Quality components of grapes are influenced by genotype, climate, cultural practices and horticultural practices. Practices aimed at improving the quality of grapes include those which improve the physical characters of bunches, berries and chemical composition of the berries. Berry size, which is the main quality factor affecting sales of table grapes in international markets, is genetically predetermined among cultivars, but it can be considerably increased by adjusting the crop load (Pollietti and Cartechini, 1998; El-Salhy *et al*., 2010; Belal *et al*., 2016), by employing cluster and berry thinning (Reynolds *et al*., 2007 and Fertel, 2011) and with the use of growth

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regulators (Abu-Zahra 2010; Ben Mohamed *et al*. 2013; El-Halaby *et al*., 2015).

Berry thinning has been used to obtain the needed loosened, large berries, highest berry weight and accelerated ripening. Thinning has a definite place as means to improve cluster and berry traits. Hand thinning plays an important role with some grape varieties since its control crop and improves its quality and hastens the ripening. The thinning necessary depended on the cultivar and sunshine as well as temperature and nutrient supply (Palliotti and Cartechini, 1998; Poni, 2003; Cheema *et al*., 2003; Selim, 2007; El-Salhy *et al*., 2010; Zhuang *et al*., 2014; Condurso *et al*., 2016; Fawzi *et al*., 2019; Omar and Aborya, 2020).

Generally, GA_3 application reduced berry set, increased berry weight, and improved juice quality (Teszlak *et al.,* 2005). Nowadays, forchlorfenuron (CPPU) is a substance derived from phenylurea with cytokinin activity that influences cell division and promotes fruit growth in various species. However, the effectiveness of treatments is timing and rate dependent (Zabadal and Bukovac, 2006; Abu-Zahra 2010; Ben Mohamed *et al*., 2013).

Sitofex has physiological effects that increased the number and density of cells causing an appreciable increase in berry size of Seedless grapes. Application of Sitofex (CPPU) showed promising results, such as increasing berry set and berry size in Thompson Seedless grape. Moreover, CPPU application at 3 to 5 ppm and GA_3 at 40 ppm gave the best bunch and berry quality (Mervet *et al*., 2001; Zabadal and Bukovac, 2006; Ben-Arie *et al*., 2008; Ben Mohamed *et al*., 2013).

So, the aim of our research was to study the effect of thinning and GA3 plus CPPU dipping on fruiting of Superior seedless grapevines.

2. Material and methods

2.1. Experimental field

This study was carried out during three successive seasons in 2020, 2021 and 2022, on 14 years old Superior seedless grapevine grown at the experimental orchard Faculty of Agriculture, South Valley University, Qena Governorate 30.42°N, 31.48 E, Egypt.

All selected vines were planted at 2 x 3 m. The vines were trained according to the traditional cane pruning system on arbors (Spanish Type). Winter pruning system was carried out in the end of December using cane pruning system leaving 96 buds (8 fruiting canes x 10 buds + 8 renewal spurs x two buds). The vines received the usual horticultural practices, concerning irrigation fertilization, pests and weeds control except those dealing with the present treatments. In addition, the best 40 bunches in the two seasons were left on each vine.

The chosen vines were divided into five different berry thinning and CPPU plus GA dipping treatments including the control. The experiment was arranged in complete randomized block design with three replications per treatment two vines each. Thus the treatments were as follow:

1- Thinning by alternatively removing about 25% from cluster branches (laterals).
2- Removing about 25% of the cluster apical.
3- Dipping 1.5 ppm CPPU and 20 ppm GA_3.
4- Dipping 3.0 ppm CPPU and 20 ppm GA_3.
5- Check (unthinned and water dipping).

Thinning treatments were performed after berry set using special shears. Whereas. GA_3 plus CPPU was done when berry at pea stage.

At harvest date, when soluble solids contents (TSS%) attained (13-14% brix) the cluster were harvested, weight and yield (kg/vine) were recorded. Three clusters were taken at random from the yield of each vine to determine the following characters.

Average of cluster weight (g), cluster length (cm), shot berries % and berries number of cluster, as well as, cluster compactness coefficient according to Winkler *et al*. (1974).

In addition, berry quality in terms of berry weight, TSS, total acidity and reducing sugars % according to A.O.A.C. (1985).

All obtained data were tabulated and statistically analyses according to Gomez and Gomez (1984) and Snedecor and Cochran (1990) using the L.S.D. test for distinguishing the significance differences between various treatment means.

3. Results

3.1. Effect of berry thinning and GA_3 plus CPPU on yield and cluster traits

It is clear from data in Tables (1 & 2) that berry thinning by removing either 25% of shoulders (T2) or 25% of cluster apical (T2) significantly decreased the berries number per cluster and consequently insignificantly decreased the cluster weight and yield/vine of Superior seedless grapevines compared to untreated one. Contrarily, both GA_3 plus CPPU dipping treatments (T3 & T4) insignificantly effected on number of berries per cluster, while significantly increased the cluster weight and yield/vine compared to untreated ones.

The reduction percentage of berries number per cluster was ranged about (20.21 & 13.04% as av. of three studied seasons) due to T1 and T2 compared to untreated ones, respectively. The corresponding decrement percentage of cluster weight attained (5.18 & 2.82 as av. of three studied seasons) respectively.

Also, the corresponding decrement percentages of yield/vine were (4.81 & 2.75% as av. of three studied seasons) due to T1 and T2 compared to control, respectively.

On the other hand, the increment percentage of cluster weight attained (9.86 & 11.91% as av. of three studied seasons) due to T3 and T4 compared to untreated ones, respectively.

Furthermore, berry thinning by removing 25% of cluster branches (T1) failed to show any significant effect on cluster length compared to untreated one (control), whereas berry thinning by removing 25% of cluster apical (T2) significantly decreased the cluster length comparable to other treatments during three studied seasons. On other hand, treated by GA_3 plus CPPU significantly increased the cluster length compared to untreated one (control).

Therefore, data in the previously tables showed significant decrease in the cluster compactness coefficient due to (T1, T3 & T4) whereas (T2) significantly increased such trait compared the control and other treatments. In additionally, all used thinning plus CPPU plus GA_3 significantly decreased the shot berries percentage compared to untreated ones (check treatment).

The decrement percentage of cluster compactness coefficient was (22.04, 9.93 & 10.01% as av. of three studied seasons) due T1, T3 & T4, respectively. On other side, the increasing percentage of such character attained (14.74% av. of three studied seasons), respectively. Also, the decrement percentage of shot berries % under checked treatment was (25.82, 22.84, 30.17 and 32.47% as an av. of the three studied seasons) due to T1, T2, T3 and T4, respectively.

Table 1. Effect of berry thinning and GA3 plus CPPU dipping on yield and cluster weight of Superior Seedless grapevines during 2020, 2021 and 2022 seasons.

Treat.	Yield vine (kg)				Cluster weight (g)			
	2020	2021	2022	Mean	2020	2021	2022	Mean
T_1	12.14	12.75	12.54	12.48	371.1	391.8	385.6	382.8
T_2	12.36	13.10	12.81	12.75	341.8	421.6	413.5	392.3
T_3	13.88	14.85	14.50	14.41	428.1	455.8	446.9	443.5
T_4	14.26	15.80	14.63	14.66	439.8	469.8	450.8	451.8
T_5	12.72	13.48	13.12	13.11	391.7	413,8	405.5	403.7
LSD 5%	0.69	0.73	0.69		19.16	28.33	18.85	

T_1- Thinning by alternatively removing about 25% from cluster branches (laterals). T2- Removing about 25% of the cluster apical. T3- Dipping 1.5 ppm CPPU and plus 20 ppm GA3. T4- Dipping 3.0 ppm CPPU plus 20 ppm GA3. T5- Check (unthinned and water dipping).

Table 2. Effect of berry thinning and GA3 plus CPPU dipping on cluster length and berry number of Superior Seedless grapevines during 2020, 2021 and 2022 seasons.

Treat.	Cluster length (cm)				Berries number/cluster			
	2020	2021	2022	Mean	2020	2021	2022	Mean
T_1	17.1	17.6	17.3	17.3	91.1	93.3	92.8	92.4
T_2	12.7	13.0	12.8	12.8	99.2	103.3	98.6	100.7
T_3	17.6	18.2	17.9	17.8	110.9	112.5	105.3	109.6
T_4	17.7	18.2	17.8	17.9	109.0	113.3	107.8	110.3
T_5	16.7	17.2	16.9	16.9	116.7	119.1	111.5	115.8
LSD 5%	0.55	0.58	0.51		8.98	7.76	7.25	

3.2. Effect of berry thinning and GA_3 plus CPPU on berry quality

Data from Tables (3 & 4) showed that berry thinning by any method and GA_3 plus CPPU dipping significantly improved the grapes quality in terms of increasing berry weight, soluble solid contents, reducing sugars and decreasing titratable acidity %. The increment of berry weight was (19.34, 12.66, 20.18 & 22.84% as an av. of three studied seasons) due to T1, T2, T3 and T4 compared to untreated ones, respectively. The corresponding increment of soluble solid contents was (8.08, 4.23, 1.96% & 0.0% as an av. of three studied seasons), respectively.

Furthermore, obtained data declared that berry thinning by removing 25% from shoulders gave the heaviest berry weight and best chemical juice quality compared to other treatments.

Table 3. Effect of berry thinning and GA3 plus CPPU dipping on cluster compactness coefficient and shot berries of Superior Seedless grapevines during 2020, 2021 and 2022 seasons.

Treat.	Cluster compactness				Shot berries %			
	2020	2021	2022	Mean	2020	2021	2022	Mean
T_1	5.46	5.37	5.18	5.34	5.68	4.73	5.11	5.17
T_2	7.92	7.96	7.61	7.86	5.87	4.95	5.30	5.37
T_3	6.28	6.20	6.02	6.17	5.31	4.48	4.80	4.86
T_4	6.22	6.23	6.03	6.16	5.11	4.36	4.62	4.70
T_5	6.96	6.89	6.70	6.85	7.52	6.48	6.88	6.96
LSD 5%	0.19	0.17	0.17		0.22	0.23	0.21	

Table 4. Effect of berry thinning and GA3 plus CPPU dipping on berry weight and TSS of Superior Seedless grapevines during 2020, 2021 and 2022 seasons.

Treat.	25 berry weight (g)				TSS%			
	2020	2021	2022	Mean	2020	2021	2022	Mean
T_1	92.19	94.91	97.35	94.82	14.10	14.52	14.31	14.31
T_2	87.51	89.26	91.76	89.51	13.63	14.00	13.78	13.80
T_3	93.95	93.78	98.25	95.94	13.34	13.68	13.48	13.50
T_4	95.69	97.31	99.81	97.60	13.12	13.41	13.18	13.24
T_5	77.31	79.41	81.62	79.45	13.08	13.43	13.19	13.24
LSD 5%	5.27	5.91	5.63		0.31	0.39	0.28	

Table 5. Effect of berry thinning and CPPU dipping on reducing sugar and titratable acidity of Superior Seedless grapes during 2020, 2021 and 2022 seasons.

Treat.	Reducing sugar %				Titratable acidity %			
	2020	2021	2022	Mean	2020	2021	2022	Mean
T_1	10.88	10.83	10.88	10.86	0.528	0.514	0.529	0.524
T_2	10.53	10.56	10.49	10.53	0.538	0.523	0.534	0.532
T_3	10.32	10.23	10.28	10.28	0.555	0.541	0551	0.549
T_4	10.15	10.12	10.10	10.12	0.565	0.550	0.562	0.559
T_5	10.10	10.13	9.98	10.07	0.561	0.543	0.551	0.552
LSD 5%	0.27	0.25	0.28		0.014	0.013	0.014	

4. Discussion

Berry thinning induce a reduction of number of berries, so the compactness coefficient was decrease. The purpose is to give individual berries enough space to fully develop and still have a fruit cluster that is not too compact so, that high quality berry is produced. Hence, there was correlated positively between percentage of removing berries or cluster shoulders and its compactness coefficient. The decreasing in berries number surely reflected in decreasing the cluster weight, consequently reduce the yield/vine.

In addition, reducing the berries number per cluster without changing the number of leaves, which reduce the competition between the berries on essential materials which lead to increase berry weight. So, it can be concluded that the berry thinning treatments accumulated carbohydrates content, which activate the process of growth and development, hence increased the berry weight and hastened ripening. These reflected on advancing the berry ripening and improving its quality for increasing sugars and soluble solid contents and decreasing total acidity. Therefore, one can be concluded that berries thinning must be done to improve the clusters and berries attributes of Superior and Ruby seedless grapes. Since, now improve in clusters and berries quality are most important target than total yield as grape quality, since results and increase in packable. The results are harmony with these obtained by many research workers, such as Palliotti and Cartechini (1998), Dhillon and Bindra (2002), Cheema *et al*. (2003), Singh and Singh (2003), Mohsen-Abeer (2005), Selim (2007), El-Salhy *et al*. (2010), Zhuang *et al*. (2014), Condurso *et al*. (2016), Fawzi *et al*. (2019) and Omar and Aboryia (2020).

Therefore, it could be concluded that berries thinning must be done to improve the clusters and berries attributes of Superior seedless grapes. From this study, it is clear that to improve cluster and berries quality we can make berry thinning as alternatively about 25% of shoulders or combined GA_3 at 20 ppm plus, CPPU at 1.5 ppm dipping.

These results illustrate the potential benefits of combining two bioregulators in the production of Superior seedless grapes CPPU applied alone increased berry size but the greatest benefits came from combining CPPU with GA_3. Reducing the rates of both bioregulators over the course of these experiments continued to produce satisfactory results, but optimum rates are still in the process of development. Furthermore, the fact that these two bioregulators were not additive in another experiment with seedless (Reynolds *et al*., 1992). Yet greatly enhanced by berry thinning or delayed harvest in other experiments, suggests to us that much is yet to be learned about the use of CPPU in commercial practice.

The effect of CPPU on fruit growth appears to be similar to that achieved with GA_3 in the early part of the growing season but an additional increase in fruit diameter occurs nearer harvest maturity. We presume that this late season growth is related to the effect of this cytokinin on early season cell division, as suggested by Ogata *et al*. (1989), but this is yet to be confirmed for table grapes. Thickening of the rachis and pedicels is consistent with this interpretation. Independent of the application significantly increased berry size and weight and the larger and heavier berries. In addition, these treatments reduce the percentage of small berries in favor of medium and larger ones. It provides a heavier bunch with large berries without affecting bunch compactness improving, therefore, the presentation and quality of fruit. Similarly, such effect was observed (Ben Mohamed *et al*., 2013) With increasing fruit size by CPPU treatment, a significant reduction in total soluble solids and pH were also observed. Similar results were reported by Du Plessis (2008). The reduction in the total soluble solids content may reflect the influence of CPPU on the maturation process by slowing the accumulation of sugars and the delay in fruit maturity. Above mentioned results were in accordance with those obtained by (Retamales, 1994; Zabadal and

Rukovac, 2006; Abu Zhara, 2010; Ben-Mohamed *et al*., 2013).

5. Conclusion

From this study, it is clear that to improve cluster and berries quality we can make berry thinning as alternatively about 25% of shoulders or combined GA_3 at 20 ppm plus, CPPU at 1.5 ppm dipping.

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Conflicts of Interest
The authors disclosed no conflict of interest starting from the conduct of the study, data analysis, and writing until the publication of this research work.

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