



Usage of Growth Regulators and Cluster Tipping to Improve Cluster Uniformity in Early Sweet Grapevine

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ABSTRACT

Shot berries is found to be one of the crucial drawbacks of the early ripening *Vitis vinifera* cv. Early Sweet as it decreases the cluster quality. The objective of this study was to assess the effect of two plant growth regulators PGR, (Gibberellic acid at 1mg/L and 20mg/L and Abscissic acid at 300mg/L) and cluster tipping in order to reduce the number of berries per cluster which led to improving berry size uniformity. Data collected from a commercial vineyard, over two successive seasons 2019-2020 comprised six treatments, suggested that all application significantly reduces berry number per cluster and improves uniformity of berry size within clusters except for the control. The results also indicated that the combined application of Gibberellic acid, Abscissic acid along with cluster tipping significantly was the highest in decreasing the number of berries/cluster and gave a uniform cluster, when applied at full bloom, besides increasing yield by lowering the number of shot berries per cluster.

Keywords: Early Sweet, Gibberellic acid, Abscissic acid, Cluster tipping and Shot berries

1. Introduction

Shot berries, is a risk problem in viticulture accompanied with the “Early Sweet” variety in which grape clusters contain berries that vary widely in size and, differ greatly in maturity. It will always have an economic impact in reduced harvest yields. The most prevailing reason for this phenomena is the bad weather which play an important role during the flowering stage of the vines, (Robinson, 2006). Moreover, in some vineyards, natural fruit set is excessive, limiting berry growth and resulting in compact clusters. However, it is desirable to carry out a berry thinning to acquire less compact clusters besides good aeration (Roberto *et al.*, 2015).

Chemical thinning reduces the labor required and allows large areas to be thinned in a relatively short period. For this purpose, some plant growth regulators are added in a specific time to improve the cluster uniformity.

Application of gibberellic acid (GA₃) increased total soluble solids and decreased the number of shot berries per cluster and cluster compactness in ‘Vanessa’ grapevines (Zabadal and Dittmer, 2000). For production of export grapes, it is recommended to treat Prime with 1-2 ppm GA₃ at full bloom, to decrease the number of berries and after 100% set with 20 ppm GA₃ to increase berry size. It has been reported that if these dosages are exceeded, a decline of fertility is observed (Van Der Merwe, 2014).

Concerning on thinning effect of Abscissic acid (ABA) depends on the bloom status of the inflorescence, with a significant effect when applied at full bloom, besides, ABA application improved uniformity of berry size within a cluster in Early Sweet grapevines (Padmalatha *et al.*, 2017).

As well as, Cluster tipping prevents compactness through removing parts of clusters after the setting of berry (Cirami *et al.*, 1992). Moreover, yield per vine and berry weight were higher when third of the cluster was removed (Dardeniz, 2014)

The purpose of this study was to assess the effect of two plant growth regulators, (Gibberellic acid at 1mg/L and Abscissic acid at 300mg/L) and cluster tipping in order to reduce the number of berries per cluster which led to improving berry size uniformity.

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2. Materials and Methods

The present investigation has been carried out during the two successive growing seasons of 2019 and 2020 at El-Sadat city, a private vineyard located in Cairo-Alexandria Desert Road, Egypt. The seven year-old vines of *Vitis vinifera* cv. "Early Sweet" were grown in a sandy soil, dripped irrigated and spaced at (2 x 3) meters. Ninety vines were chosen for this study (6 treatments x 3 replicates x 5 vines /replicate) arranged in a Randomized Complete Block Design, carefully selected to be nearly uniform in vigor as possible and receiving regularly the same horticultural practices. Vines were trained according to the Spanish Parron system, with a bud load of 70 buds/vine (10 canes x 7 buds). Pruning was carried on the last week of December.

Gibberellic GA₃ acid at 1 mg/L and 20mg/L and Abscisic acid ABA at 300mg/L (formulated in 0.025% Triton X-100 as surfactant) were sprayed on the clusters twice, the first when about 75% of the clusters in the row were blooming. Gibberellic acid was sprayed at a concentration of 1 mg/L and was repeated when the berry size reached (6-8 mm) with a concentration of 20 mg/L. In addition, clusters were tipped by removing about 30 % of the apical portion of clusters at fruit set when berry size was (5-7 mm).

The treatments were outlined as follows:

1. Control
2. Gibberellic acid
3. Abscisic acid
4. Tipping of clusters
5. Gibberellic acid + Abscisic acid
6. Gibberellic acid + Abscisic acid +Tipping

The following measurements were taken to evaluate the effect of different treatments:

2.1. Yield

Samples of clusters were collected randomly when berries TSS% reached about 15-17 Brix, according to Tourky *et al.*, (1995) and the following analysis were carried out:

- a- Yield per vine (kg): random samples were collected and weighed then the mean of cluster weight was multiplied by the number of clusters / vine to calculate the average yield/vine.
- b- Average cluster weight (g).
- c- Average berry weight (g).
- d- Number of berries/cluster.
- e- Number of shot berries / cluster.
- f- The shot berries (%): clusters were harvested and the percentage of shot berries in each cluster were calculated according to the following equation:

The shot berries (%) = Number of shot berries / number of total berries per cluster x 100.....(1)

2.2. Chemical characteristics

- Total soluble solids (TSS %)
- Titratable acidity (A.O.A.C., 1985)
- TSS / acid ratio.
- Total chlorophyll content in Leaves at full bloom, from the apical 5th, 6th leaves (Wood *et al.*, 1992).

2.3. Vegetative growth

Ten vegetative shoots and ten fruitful shoots per vine were labeled and measured at growth cessation as follow:

- The average leaf area (cm²): The apical 5th, 6th and 7th leaves (were measured using planimeter).
- Shoot length (cm).

2.4. Statistical analysis

All data obtained during both seasons of the present investigation were statistically analyzed using the analysis of variance method according to Snedecor and Cochran, (1980) and treatments means were compared according to New LSD at $P < 0.05$ level of probability.

3. Results and Discussion

3.1. Yield

Yield per vine (kg), Cluster weight (g), Average berries weight (g), number of berries/cluster and the percentage of shot berries (%)

Data displayed in table (1) revealed that, in comparison to control treatment, the combined application of Gibberellic acid, Abscisic acid along with tipping significantly increased grapevine yield, cluster weight and berries weight followed by the other applications with no significant differences between them except for the control which gave a significant lower value. Whereas, number of berries/cluster was lower and accordingly resulting of about 77.6 % decrease in the percentage of shot berries than the control where 12.5% and 12.3% was reduced to 2.8% and 2.4% in both seasons respectively (figure 1).

Table 1: Effect of growth regulators and tipping on yield in early sweet grapevine during both seasons 2019 and 2020.

Treatments	Cluster weight (g)		No. of clusters/vine		Yield / vine (Kg)		Berry weight (g)		No. of berries per cluster		No. of Shot berries	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Control	415.5	392.4	30.1	29.9	12.5	11.7	3.7	3.5	112.3	112.1	14.0	13.8
GA ₃	431.4	436.0	33.1	33.0	14.2	14.4	4.2	4.3	102.7	101.4	7.9	7.7
ABA	427.4	435.6	32.6	31.7	14.0	13.8	3.9	4.0	109.6	108.9	8.3	8.0
Tipping of clusters	438.3	425.5	31.6	31.1	13.8	13.2	4.5	4.4	97.4	96.7	5.1	5.3
GA ₃ + ABA	440.1	438.5	33.8	33.9	14.8	14.9	4.8	4.7	91.7	93.3	3.9	4.2
GA ₃ + ABA+ Tipping	451.8	446.3	35.3	35.4	15.9	15.7	5.1	5.1	88.6	87.5	2.5	2.1
New LSD at 0.05%	8.0	7.0	0.3	0.3	0.6	0.5	0.2	0.1	3.1	3.0	0.5	0.4

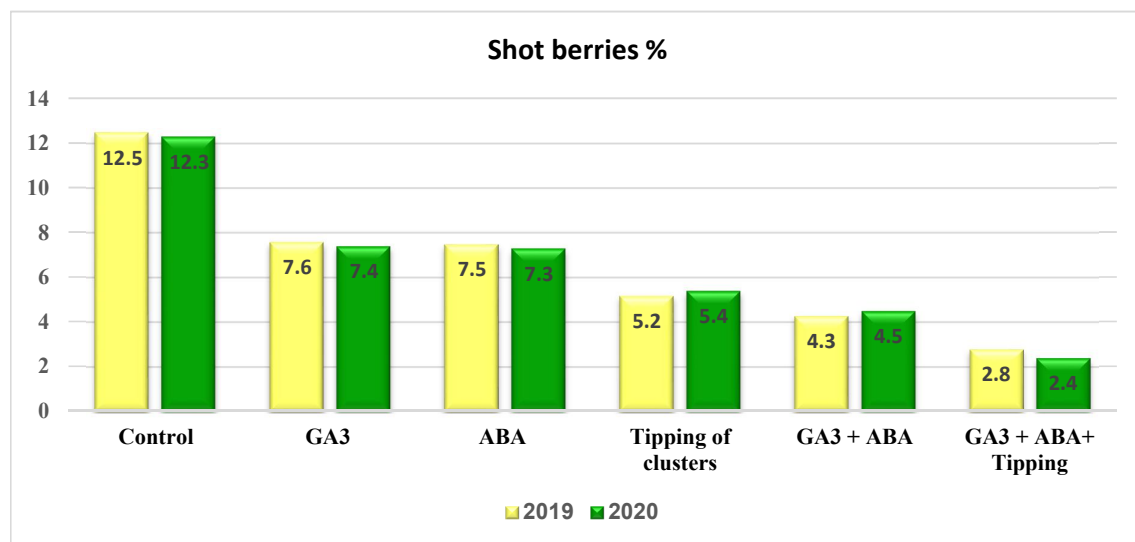


Fig. 1: The percentage of shot berries as affected by each treatment in both seasons

Tipping has been used as an effective method to obtain loosened clusters, large berries, in addition to a highest berry weight (El-salhy *et al.*, 2009). Moreover, Cengiz *et al.* (2012) stated that supplementary addition of Gibberellins applied at full bloom decrease the berry set and when it is sprayed at berry set the size of the remaining berries was increased. Similar to the above mentioned results, it can be concluded that applications did not lead to a great loss in yield, as the competition between berries rather than between clusters found to be the main reason of the formation of shot berry in Early Sweet and applying an early cluster thinning chemically by using ABA may be ascribed to the increment of the number of clusters per vine (Padmalatha *et al.*, 2017). GA₃-treated clusters were less compact than the ABA-treated treatment, however, there was no significant difference between them but ABA significantly reduced the percent shot berries compared to control (Gohil and Ward, 2020).

3.2. Chemical characteristics of berries and leaves

3.2.1. Total soluble solids (TSS %), Titratable acidity % and TSS / acid ratio

The significant differences among treatments in TSS %, titratable acidity and TSS /acid ratio are clearly presented in table (2) showing that spraying the clusters at full bloom with Gibberellic acid at 1mg/L, Abscisic acid at 300 mg/L along with tipping is significantly associated with improving the chemical characteristics of berries in relative to the other treatments and the control in both seasons. Similar results were obtained by Mekawy and Ahmed, (2018) who revealed that treating the vines with ABA 400 mg/L increased the TSS % and TSS/acidity ratio whereas; acidity was decreased in berry juice. Moreover, Mohsen and Ali, (2019) indicated that in 1ppm GA₃ treatment total soluble solids (TSS %) was significantly higher than the control. Regarding to the effect of tipping on Total soluble solids %. Fawzi *et al.* (2019) mentioned that T.S.S was highest with cluster tipped at fruit set.

3.2.2. Leaf pigments content (chlorophyll)

Total chlorophyll content in the leaves was positively affected by treating the vines with the plant growth regulator (PGR) along with tipping process (Table, 2). The single and double addition treatments increased the chlorophyll content but the triple application of Gibberellic acid at 1mg/L, Abscisic acid at 300 mg/L and tipping, were significantly superior to that of all treatments and the control in this concern. Foliar GA₃ application also led to increasing leaf chlorophyll content (Zang *et al.*, 2016). In addition, non-ABA-treated plants had lower concentrations of photosynthetic pigment, whereas those sprayed with ABA 200 mg/L had an increase in the total Chlorophyll content (Karimi *et al.*, 2016).

Table 2: Effect of growth regulators and tipping on the chemical characteristics of berries and leaves in early sweet grapevine during the two successive seasons 2018 and 2019

Treatments	TSS %		Acidity %		TSS/acid Ratio		Chlorophyll content (SPAD)	
	2019	2020	2019	2020	2019	2020	2019	2020
Control	13.2	13.9	0.75	0.71	17.6	19.5	20.5	21.0
GA ₃	13.8	14.3	0.71	0.68	19.4	21.0	27.0	27.5
ABA	14.6	14.9	0.67	0.64	21.7	23.3	24.9	25.3
Tipping of shoots	16.2	16.1	0.57	0.58	28.4	27.8	22.6	23.1
GA ₃ + ABA	15.4	15.6	0.62	0.60	24.8	26.0	29.5	28.9
GA ₃ + ABA+ tipping	16.9	16.8	0.53	0.51	31.8	32.9	31.7	32.2
New LSD at 0.05%	0.5	0.3	0.03	0.02	1.6	1.6	1.8	1.9

3.3. Morphological measurements

3.3.1. Leaf area (cm²) and Shoot length (cm)

Leaf area development is a decisive characteristic affecting yield and fruit quality of grapevines. The effect of different treatments (fig. 2) revealed that the highest data values were obtained from treating the vines with both PGR plus cluster tipping at full bloom followed by adding the PGR without tipping then the single applications respectively in both seasons. Also, it is evident from the displayed data that shoot length has a significant stimulation by applying the same treatments. These results are in harmony with those of Zang *et al.* (2016) who mentioned that foliar application of these plant growth regulator led to the longer shoots and larger leaves and subsequent higher yield. Another linear results

obtained through applying cluster tipping from Fawzi *et al.*, (2019) who found that tipping increased grapevine shoot length in both seasons compared with the check treatment.

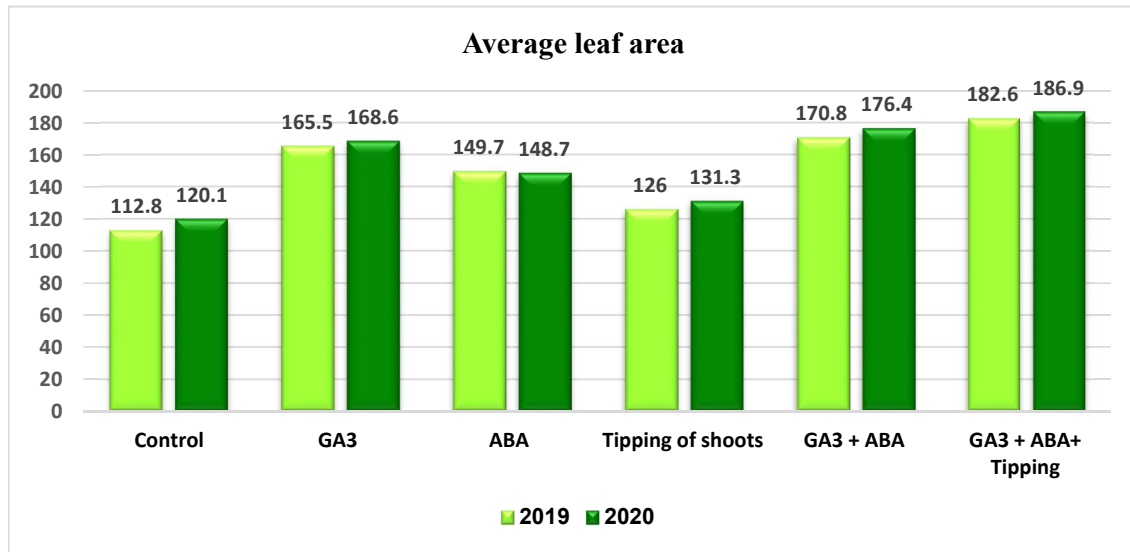


Fig. 2: average leaf area as affected by different treatments in both seasons 2019 and 2020

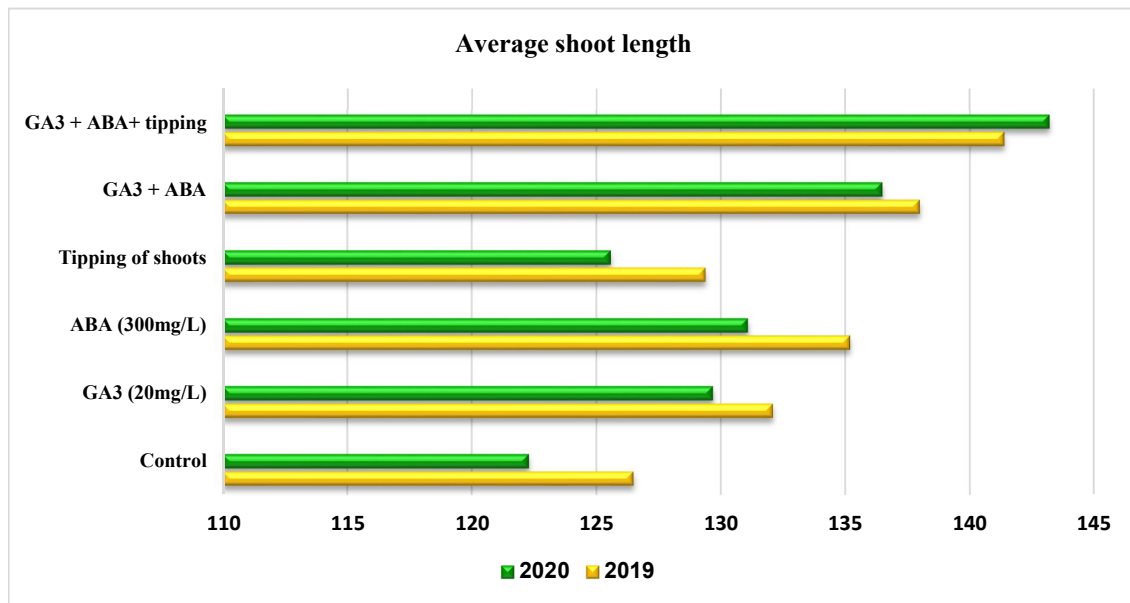


Fig. 3: Average shoot length as affected by different treatments in both seasons 2019 and 2020

Conclusion

It could also be said that using plant growth regulators accompanied with cluster tipping was an effective treatment in achieving a cluster uniformity by reducing the percentage of shot berries per cluster along with increasing the yield per vine. Yield compensation was fulfilled by an increase in berry weight of about 27 %, in response to a reduction of 21%, in berry numbers; which resulted in a yield increase of 21 % than the control in both seasons. In addition to enhancing the chemical characteristics of berries, TSS %, TSS/acidity ratio whereas, acidity% was decreased in berry juice and improved all vegetative growth parameters.

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