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Improving Fruit Quality of Crimson Seedless by Ethephon and Abscisic Acid Foliar Applications Using Three Machine Types

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THIS study was conducted in two successive seasons 2017 and 2018 on 'Crimson Seedless' vines budded on Richter 110 rootstock at four years old, grown in a private orchard at Al Qattah, Giza Governorate, Egypt, to improving fruit quality, especially color. using three Spray machines (**1-**Electrostatic ESS **2-** Cima **3-** backpack sprayers) and six foliar applications of materials concentration (500ppm Ethephon, 1000ppm Ethephon, 2000ppm Ethephon, 500ppm Abscisic acid, 1000ppm Abscisic acid and 2000ppm Abscisic acid) at veraison. Fruit quality, especially TSS/acid ratio and Anthocyanin content were increased when spraying by ESS followed closely by Cima spray machines. 2000ppm of Abscisic acid gave the significant highest values of Anthocyanin content followed by 1000ppm ABA and 2000ppm Ethephon, while there was no significant differential effect of them on TSS/acid ratio. On the other hand, the firmness decreased when spraying by 2000ppm and 1000ppm from Ethephon and Abscisic acid. Therefore, it can be recommended to get the best color and TSS/acid ratio for berries of Crimson seedless grape should be spraying 1000ppm Abscisic acid or 2000ppm Ethephon at veraison by ESS or Cima spray machines.

Keywords: Crimson seedless, Ethephon, Abscisic Acid, yield, Fruit quality, Spray machines.

Introduction

Table grapes in Egypt is considered one of the most important export crops, area of grapes in Egypt accomplished a noticeable increase reaching 174575 Feddan producing 1626259 tons while, the quantities exported during the 2019 season of Egyptian grapes were estimated about 154207 tons according to (FAO, 2019), Crimson seedless cultivar is one of the late red grapes to be harvested in the season, it has a great taste, attractive shape, crunchy, and withstands long shipping. In colored grapes, Berry color is one of the most important quality factors (Nikolaos Nikolaou et al., 2003, Samaan and Nasser, 2020), However in the warm climates does not give adequate red color berries (Celia et al., 2007). The most important reason for this, may be due to in warm the regions high temperatures inhibit the accumulation of anthocyanins (Spayd et al., 2002). The commercial product of Ethephon is Ethrel 480 sl was the source of Ethephon 480 g/ liter. Ethephon (2-Chloroethylphosphonic acid) is a plant growth regulator used to promote fruit ripening, abscission and other responses. Ethephon is similar in action to ethylene in its effects in enhancing color development and improving fruit quality characteristics of table grapes (Cecilia and Fidelibus, 2008, Samaan and Nasser, 2020). Grape›s coloration is associated with anthocyanins, it›s beginning to accumulate at veraison and seems to be regulated, partially, by abscisic acid (ABA) (Ban et al., 2003 and

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Renata Koyama et al., 2014). Abscisic acid (ABA) is one of the "classical" plant hormones, i.e. discovered at least 50 years ago, that regulates many aspects of plant growth and development (Finkelstein, 2013) .(ProTone®) provided by Valent Biosciences, USA, containing 10% of abscisic acid (S-ABA) this is using to improve color in grapes berries. The efficiency of foliar application process in grapes affects the quality and color of the clusters. To enhance application effect, different spraying systems and nozzle configurations are selected by adjusting system parameters. The nozzle type, position, angle, as well as system parameters including flow rate and application pressure, invariably affect spray characteristics such as the droplet sizes, velocity and spray swath (Taylor et al., 2004, Nuyttens et al., 2007, Klein et al., 2009 and Samuel Appah et al., 2019)

A spray application is most effective when the optimal droplet size for the intended target is utilized. In order to deliver optimal sprays, nozzle companies have developed innovations that aim to provide the greatest coverage per unit area. (Ferguson, 2016). The smaller droplets may improve efficiency because they cover better, injure the target area less, and penetrate and translocate the active substance more. **(**Prokop and Veverka, 2003). A significant amount of the chemical applied in many spray systems is wasted. To try to overcome this, some farms have resorted to using machines that reduce the wastage of spray solution, such as those that contain air induction nozzles. The air-filled droplets tended to explode and fracture into many smaller droplets, increasing the potential for spreading on the leaves (Miller & Lane 1999 and Świechowski et al., 2014). ESS spraying can provide a solution for these problems. Whereas ESS spraying achieves more complete coverage of difficult targets than uncharged spraying in addition to minimizing wastage and environmental impact from over spray and spray drift. (Al-Mamury et al., 2020) Pneumatic spraying (CIMA) is a well-known technique for its fine droplet size generation. this technique is very widespread, especially among large-farm vine growers in Europe ans America whereas, the small droplets achieve a uniform target spray coverage (Grella et al, 2020).

The aim of this study was to improve quality properties of Crimson seedless grape vines, especially color, by spraying Ethephon and ABA with different concentrations through newly spraying machine types, named cima SPA. and ESS spraying system.

Materials and Methods

Selected mature and uniform 'Crimson Seedless' vines budded on Richter 110 rootstock at four years old, grown in a private orchard at Al Qattah, Giza Governorate, Egypt in two successive seasons (2017 and 2018), planted at 2 x 3 meter apart, in sandy soil under drip irrigation system. The vines were trellised by the Spanish Parron system. The vines pruned during the last week of December to twelve fruitful canes and each one contained eight eyes. Thus, the bud load was ninety-six eyes/vine. Thirty-five clusters were left per vine. A split-plot field trial using three Spray machines (**1-**Electrostatic ESS **2-** Cima **3-** backpack sprayers (20L Agricultural Electric Sprayer 12V)) and six levels of Ethephon and Abscisic Acid foliar applications.

ESS (ESS 150RB) from maxcharge co. USA / Cima plitz50 from CIMA S.P.A Italy, the Calibrations of these machines were made in the field using different pressures and discs.

The experiment was laid out in four blocks of three main plots, each split into six sub-plots. The Spray machines were applied to the main plots and the foliar applications to the sub-plots. Each treatment included four replicates and each replicate was represented by one vine.

At veraison each spray machine applied the following treatments:
(1) Ethephon 500 ppm
(2) Ethephon 1000 ppm
(3) Ethephon 2000 ppm
(4) abscisic acid 500 ppm
(5) abscisic acid 1000 ppm
(6) abscisic acid 2000 ppm

Abscisic acid (ABA) was used as trademark (ProTone®) which contain S-ABA 10%. The commercial product of Ethephon is Ethrel 48، sl was the source of Ethephon 480 g/liter. The vine had received in the spraying solution to the runoff. The volume of each material solution was: ESS 60 liters per feddan, Cima 300 liters per feddan, Backpack sprayers was 700 liters per feddan.

Coverage Efficiency (CE)

Coverage efficiency given in number of droplet/cm^2. In order to calculate, putting four cards divided into centimeter squares (Fig. 1) at the same level as the grape clusters to receive the

spray drops, then calculating number of droplet/ cm^2 using with a Nikon coolpix P950 and ImageJ software for image analysis. Download (nih.gov) at three squares were randomly selected**.**

Pruning wood weight

Pruning's wood weight (kg) was weighted Yield

At ripe stage in mid-September which was determined when T.S.S reached 15- 16 % in used traditionally in the used orchard in each season, ten clusters from each vine (replicate) were weighed and then the yield (Kg) of each vine was estimated.

Fruit quality

A hundred berries were randomly selected and weighted. Fruit firmness was measured with fruit texture analyzer model GS-, serial NO. FTA2 expressed as Newton. Hand refractometer model HR-110 was used for determining total soluble solids (TSS) as a percentage in the juice. The treatable acidity was determined by titrating 10 ml of the juice against sodium hydroxide (0.1 N) and phenolphthalein 1% as indicator according to (A.O.A.C. 2006). The acidity was calculated as mg Tartaric acid per 100 ml of juice. Then TSS/ acid ratio was determined. Anthocyanin was extracted from 50 mg of frozen skin samples. extracting the anthocyanins with ethanol 1.5N hydrochloric acid (85:15)and measuring the O.D. (the absorbancy reading on the diluted sample) of the extract by a spectrophotometer, diluted with the extracting solvent, at 535 nm. The total anthocyanin content was calculated in absolute quantities according to the method of (Fuleki and Francis 1968).

Statistical analysis

The data were submitted to the proper statistical analysis of variance according to Snedecor and Cochran (1980). Tukey test was used to compare between means. Data were statistically analyzed using the analysis of variance adopting a SAS package.

Results and Discussion

Coverage Efficiency (CE)

Data presented in Fig. 2 show the coverage efficiency for ESS, Cima and backpack sprayers. the better surface coverage is obtained by ESS and Cima compared to backpack sprayers, where the number of droplet per square centimeter was higher when using both ESS and Cima (1280-1600 droplet /cm^2 respectively). This is due to effect of nozzle type and spraying machine pressure on coverage efficiency. As Cieniawska et al. (2019) explained that the coverage is dependent variables for droplet size, which are affected by the type of nozzle and spray pressure for spraying machine.

Pruning wood weight

Result in Table 1 show the effect of machine type and material type with different concentration and their interaction on pruning wood weight per vine (kg) of Crimson seedless grape during 2017 and 2018 seasons. Pruning wood weight was affected significantly only by material type and interaction in the two seasons. In respect to material type, 500ppm Ethephon and 500ppm ABA gave the highest significant values in the two seasons. Regarding to the interaction the highest significant values were recorded by three machine

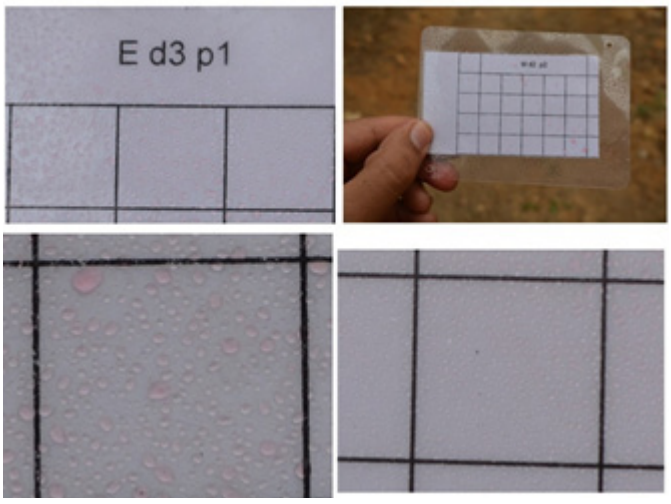

Fig. 1. card divided into centimeter squares was used to receive the spray drops

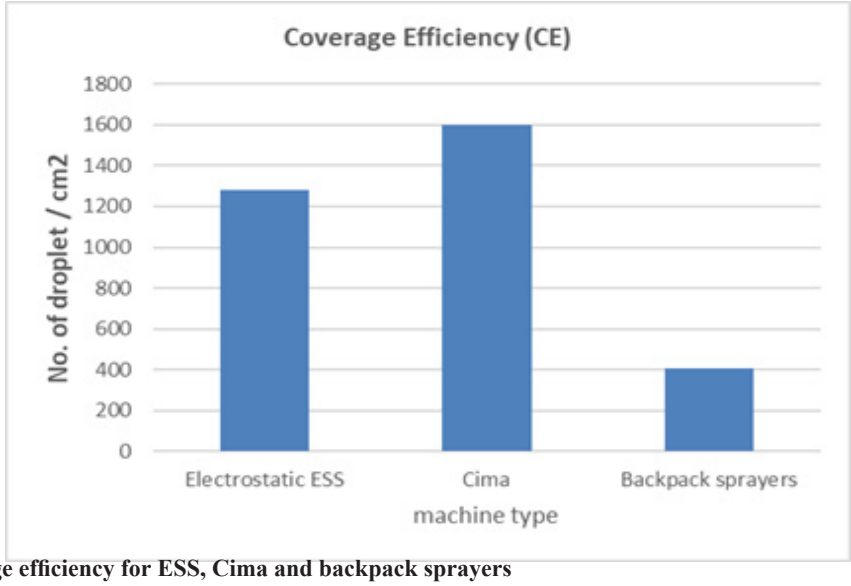

Fig. 2. coverage efficiency for ESS, Cima and backpack sprayers

TABLE 1. Effect of machine type and material type with different concentration on pruning wood weight per vine (kg) of Crimson seedless grape during 2017 and 2018 seasons.

Machines \ Material type	Ethephon(ppm)			Abscisic acid(ppm)			mean
	500	1000	2000	500	1000	2000	
2017 season							
Electrostatic ESS	2.41a-e	2.10d-g	2.10d-g	2.44a-d	2.32b-f	1.89g	2.21A\
Cima	2.58ab	2.59ab	2.07e-g	2.52a-c	2.00fg	1.30h	2.18A\
Backpack sprayers	2.71a	2.22c-g	2.08e-g	2.32b-f	2.22c-g	1.88g	2.24A\
mean	2.57A	2.30BC	2.08D	2.42AB	2.18CD	1.69E	
2018 season							
Electrostatic ESS	2.26a-c	2.08c-f	1.92f	2.37a	2.11b-f	1.96ef	2.12A\
Cima	2.28ab	2.05d-f	2.06d-f	2.20a-d	2.05d-f	2.00ef	2.10A\
Backpack sprayers	2.29ab	2.14b-e	2.02d-f	2.20a-d	2.11b-f	1.98ef	2.12A\
Mean	2.27A	2.09B	2.00C	2.26A	2.09B	1.98C	

In each season, means of each of concentration of each spraying material and spraying machine type or their interaction having the same letter (s) are not significantly different at 5% level.

type under the first level of Ethephon followed closely by all machine type under the first level of ABA especially in the second season. Similar results were observed in another experiment, spraying with ethephon led to a reduction in the weight of winter pruning wood in grapes compared to grapes not treated with the treated vines (Kamiloğlu and Polat, 2019).

Yield

Result in Table 2 present the effect of machine type and material type with different concentration and their interaction on yield/vine (kg) of Crimson seedless grape during 2017 and 2018 seasons. Yield/vine (kg) was affected significantly only by material type and interaction in the two seasons. Regarding material type, 2000ppm of Ethephon

gave the significant highest values of yield per vine followed closely by 2000ppm of abscisic acid. Regarding to the interaction it was clear that, the highest significant values were recorded by three machine type under 2000ppm Ethephon and 2000ppm abscisic acid followed closely by ESS machine under 1000 ppm Ethephon and 1000ppm abscisic acid in the two seasons. This is due to effect of both Ethephon and ABA on the weight of the berries, which led to an increase in the weight of yield, in agreement with (Amiri et al., 2010).

Cluster weight

Result in Table 3 show the effect of machine type and material type with different concentration and their interaction on cluster weight (gm) of Crimson seedless grapes during 2017-2018 seasons. weight of cluster was affected significantly only by material type and interaction in the two seasons. Regarding the effect of the material type, the results obtained showed that 2000ppm of Ethephon and 2000ppm of abscisic acid gave the highest significant values. In general, cluster weight increased whenever increasing the concentration of the spring materials .The interaction pointed out that the significant highest values were observed by three machine type under 2000ppm and 1000ppm of Ethephon and abscisic acid in the two seasons. The increase of cluster weight was closely correlated with water accumulation in the berries due to ABA application (Mohamed et al., 2019).

Weight of 100 berries

Result in Table 4 show the effect of machine type and material type with different concentration and their interaction on weight of 100 berries (mg) of Crimson seedless grapes during 2017-2018 seasons. Weight of 100 berries values were significantly affected by machine type and material type with different concentration and their interaction especially in the first season. Cima machine was obtained the significant highest values in the first season. On the other hand, 1000ppm and 2000ppm of Ethephon gave the significant highest values of the weight of 100 berries followed closely by 2000ppm of abscisic acid. The interaction was clear that, the significant highest values were obtained when spraying by 2000 ppm Ethephon and 2000 ppm abscisic acid with ESS and Cima and 1000ppm Ethephon with Cima in the two seasons. The increase of weight of 100 berries because the ability of ABA to close the stomata on the berry surface Which varies his number among grape cultivars, but the average of stomata number was found to be 16 (Nakagawa et al., 1980), subsequently decrease the transpiration rate and reflected on the increase, of water accumulation in berries. Transpiration of the grape berry was happened from anthesis until the fruit maturation (Mohamed, et al., 2019).

In this concern Aly et al. (2020) concluded that, increasing abscisic acid concentration up to 200 mg/l; resulted in the higher mean values of cluster length, cluster diameter, cluster weight,

TABLE 2. Effect of machine type and material type with different concentration on yield/vine (kg) of Crimson seedless grape during 2017 and 2018 seasons.

Material type / Machine	Ethephon(ppm)			Abscisic acid(ppm)			mean
	500	1000	2000	500	1000	2000	
2017 season							
Electrostatic ESS	16.61g	18.56a-c	18.54a-c	17.17e-g	18.19a-d	18.40a-c	17.91A\
Cima	17.03fg	18.19a-d	18.82a	17.29e-g	17.84c-e	18.48a-c	17.94A\
Backpack sprayers	16.65g	18.04b-d	18.61ab	17.00fg	17.56d-f	18.61ab	17.75A\
Mean	16.76E	18.26B	18.66A	17.15D	17.86C	18.50AB	
2018 season							
Electrostatic ESS	17.13ab	17.34ab	19.41a	17.07b	17.59ab	17.54ab	17.68A\
Cima	17.39ab	18.90ab	19.08ab	17.58ab	17.91ab	18.28ab	18.19A\
Backpack sprayers	16.84b	18.43ab	18.17ab	17.31ab	17.72ab	17.78ab	17.71A\
Mean	17.12C	18.22AB	18.89A	17.32BC	17.74BC	17.87A-C	

In each season, means of each of concentration of each spraying material and spraying machine type or their interaction having the same letter (s) are not significantly different at 5% level.

TABLE 3. Effect of machine type and material type with different concentration on cluster weight (gm) of Crimson seedless grapes during 2017-2018 seasons.

Material type / Machine	Ethephon(ppm)			Abscisic acid(ppm)			mean
	500	1000	2000	500	1000	2000	
2017 season							
Electrostatic ESS	474.62f	512.76a-e	529.81ab	490.48c-f	519.72a-d	525.81a-c	508.87A\
Cima	486.47d-f	519.62a-d	537.62a	493.90b-f	509.72a-f	527.90a-c	512.54A\
Backpack sprayers	475.71ef	505.81f	531.81a	485.71d-f	501.81a-f	531.81a	505.44A\
Mean	478.93D	512.73BC	533.08A	490.03D	510.41C	528.51AB	
2018 season							
Electrostatic ESS	489.33ab	495.33ab	554.67a	487.67b	502.67ab	501.00ab	505.11A\
Cima	496.67ab	540.00ab	545.00ab	502.33ab	511.67ab	522.33ab	519.67A\
Backpack sprayers	481.00b	526.67ab	519.00ab	494.67ab	506.33ab	508.00ab	505.94A\
Mean	489.00C	520.67AB	539.56A	494.89BC	506.89BC	510.44A-C	

In each season, means of each of concentration of each spraying material and spraying machine type or their interaction having the same letter (s) are not significantly different at 5% level.

TABLE 4. Effect of machine type and material type with different concentration on weight of 100 berries (mg) of Crimson seedless grapes during 2017-2018 seasons.

Material type / Machine	Ethephon(ppm)			Abscisic acid(ppm)			mean
	500	1000	2000	500	1000	2000	
2017 season							
Electrostatic ESS	353.33h	510.00a-d	518.33a-c	380.00gh	456.67c-e	516.67a-c	455.83B\
Cima	472.00b-e	526.00ab	512.33a-c	468.33b-e	526.67ab	538.33a	507.28A\
Backpack sprayers	416.67e-h	465.00b-e	440.00e-g	385.00f-h	448.33d-f	473.33b-e	438.06C\
Mean	414.00C	500.33AB	490.22AB	411.11C	477.22B	509.44A	
2018 season							
Electrostatic ESS	474.00ab	486.67ab	530.33a	465.00b	488.67ab	487.67ab	488.72A\
Cima	482.67ab	520.67ab	530.00a	489.00ab	490.67ab	511.67ab	504.11A\
Backpack sprayers	465.00b	507.67ab	502.00ab	482.67ab	489.67ab	495.33ab	490.39A\
mean	473.89C	505.00AB	520.78A	478.89BC	478.87BC	498.22A-C	

In each season, means of each of concentration of each spraying material and spraying machine type or their interaction having the same letter (s) are not significantly different at 5% level.

yield / vine and yield/fed. as compared with control treatment. On the contrary (Giuseppe et al., 2013) found that, neither berry weight, bunch weight, nor yield were affected.

Fruit quality

Result in Table 5,6,7,8 and 9 show the effect of machine type and material type with different concentration and their interaction on fruit quality of Crimson seedless grapes during 2017-2018 seasons. All studied fruit quality were insignificantly affected by machine type except firmness and Anthocyanin. On the other hand, all studied fruit quality were significantly affected by material type and their interaction.

Regarding acidity % data in Table 5 showed that the significant less values were obtained by ESS in the second season only. In respect to material type, 2000ppm ABA in the first season and 1000ppm in the second season gave less significantly values. While the interaction it was clear that, the significant less values were obtained when spraying by 2000 ppm abscisic acid with ESS and Backpack sprayers and 1000 ppm abscisic acid with Cima in the two seasons.

Result in Table 6 present the effect of machine type and material type with different concentration and their interaction on TSS% of Crimson seedless grapes fruits during 2017-2018 seasons. In the two seasons, the T.S.S were significantly affected by the concentration of spray materials and the interaction between the type of spray and the concentration of the spray materials. The TSS% not affected significantly by spraying type through the two seasons. Regarding the effect of the spraying material concentration, the results obtained showed that 2000ppm of abscisic acid and 2000 ppm Ethephon gave the highest significant values. In general, the TSS% increased by increasing the concentration of the material type. Regarding the interaction, the significant highest values were obtained by 1000ppm and 2000 ppm of abscisic acid with the three spraying types and 2000ppm Ethephon with the three spraying types and 1000ppm of Ethephon with ESS and Cima.

TABLE 5. Effect of machine type and material type with different concentration on acidity % of Crimson seedless grapes during 2017-2018 seasons.

Material type / Machine	Ethephon(ppm)			Abscisic acid(ppm)			mean
	500	1000	2000	500	1000	2000	
2017 season							
Electrostatic ESS	0.54ab	0.69ab	0.81a	0.55ab	0.74ab	0.47b	0.63A\
Cima	0.71ab	0.67ab	0.74ab	0.59ab	0.48b	0.66ab	0.64A\
Backpack sprayers	0.76ab	0.53ab	0.61ab	0.61ab	0.65ab	0.49b	0.61A\
mean	0.67AB	0.63AB	0.72A	0.59AB	0.62AB	0.54B	
2018 season							
Electrostatic ESS	0.59b-d	0.73a-d	0.88ab	0.59b-d	0.71a-d	0.50d	0.67B\
Cima	0.78a-d	0.75a-d	0.84a-c	0.91a	0.52d	0.90a	0.78A\
Backpack sprayers	0.89a	0.65a-d	0.66a-d	0.88ab	0.70a-d	0.57cd	0.72AB\
mean	0.75AB	0.71AB	0.79A	0.79A	0.64B	0.66AB	

In each season, means of each of concentration of each spraying material and spraying machine type or their interaction having the same letter (s) are not significantly different at 5% level.

TABLE 6. Effect of machine type and material type with different concentration on TSS% of Crimson seedless grapes during 2017-2018 seasons.

Material type / Machine	Ethephon(ppm)			Abscisic acid(ppm)			Mean
	500	1000	2000	500	1000	2000	
2017 season							
Electrostatic ESS	15.67d	17.17a-d	17.83a-d	16.00cd	17.33a-d	17.33a-d	16.89A\
Cima	15.83d	17.00a-d	17.17a-d	15.67d	18.17a-c	18.67a	17.17A\
Backpack sprayers	15.83d	16.33b-d	18.33ab	16.33b-d	17.00a-d	18.33ab	17.03A\
mean	15.78C	16.83BC	17.94A	16.00C	17.50AB	18.11A	
2018 season							
Electrostatic ESS	18.67a	19.67a	20.00a	19.00a	19.67a	20.00a	19.50A\
Cima	18.67a	19.67a	20.00a	19.33a	20.00a	20.00a	19.61A\
Backpack sprayers	19.33a	20.00a	20.00a	19.00a	19.67a	20.00a	19.67A\
mean	18.89C	19.78AB	20.00A	19.11BC	19.78AB	20.00A	

In each season, means of each of concentration of each spraying material and spraying machine type or their interaction having the same letter (s) are not significantly different at 5% level.

Result in Table 7 show the effect of machine type and material type with different concentration and their interaction on TSS/acid ratio of Crimson seedless grape fruits during 2017 and 2018 seasons. Concerning the spraying type, TSS/acid ratio were the highest value with ESS in the two seasons.

With respect to the specific effect of concentration of materials, the obtained data showed that 1000ppm and 2000 ppm of abscisic acid gave the significant highest values. Regarding the interaction, the significant highest values were obtained by500 ppm and 2000 ppm of abscisic acid and 500ppm of Ethephon with ESS and 1000 ppm abscisic acid with Cima and 1000ppm,2000ppm of Ethephon and 2000 ppm abscisic acid with Backpack sprayers during the two seasons. This is due to reducing vegetative growth and thus reducing the consumption of nutritional compounds within plants, which was reflected on the content of fruits from TSS% and acidity%. It was moreover detailed that abscisic acid hastens the initiation of sugar accumulation, by stimulating the uptake and storage of sugars by berries (Davies and Böttcher, 2009).

Result in Table 8 show the effect of machine type and material type with different concentration and their interaction on firmness (Newton) of Crimson seedless grape fruits during 2017 and 2018 seasons. The spraying with ESS gave the significant highest values firmness of berries through the two seasons. With respect to the specific effect of concentration of materials, the obtained data showed that 500ppm of Ethephon gave the significant highest values and the lowest values was 2000 ppm of Ethephon and abscisic acid. Generally, the firmness decreased by increasing the concentration of the material type. Regarding the interaction, the significant highest values were obtained by 500ppm of Ethephon with ESS and Backpack sprayers during the two seasons.

Result in Table 9 and Fig. 3 present the effect of machine type and material type with different concentration and their interaction on Anthocyanin (mg/100g) of Crimson seedless grape fruits during 2017 and 2018 seasons. ESS and Cima gave the highest values in the two seasons. On the other hand,2000ppm of abscisic acid gave the significant highest values in the two seasons. Regarding the interaction it was clear that, the significant highest values were obtained when spraying by 2000 ppm of abscisic acid with three spraying types and 2000ppm Ethephon with Backpack sprayers in the two seasons.

Generally, fruit quality was increased when spraying by ESS as their use led to a decrease in the amount of spraying used while increasing the efficiency of spraying, due to the ESS application solution spraying ,droplets deposition, impinging, rebound and drift inefficiencies have been reduced due to substrate attraction. There has been the wraparound effect of droplets pinning on substrates to reduce off-target deposition, enhances on-target

TABLE 7. Effect of machine type and material type with different concentration on TSS/acid ratio of Crimson seedless grapes during 2017-2018 seasons.

Material type / Machine	Ethephon(ppm)			Abscisic acid(ppm)			mean
	500	1000	2000	500	1000	2000	
2017 season							
Electrostatic ESS	29.013a-c	25.067c	24.020c	29.037a-c	23.507c	37.197ab	27.97A\
Cima	23.037c	25.427bc	24.133c	27.110a-c	37.983a	29.000a-c	27.78A\
Backpack sprayers	21.187c	31.020a-c	29.860a-c	27.370a-c	26.143a-c	37.687a	28.88A\
mean	24.41B	27.17B	26.00B	27.84B	29.21AB	34.63A	
2018 season							
Electrostatic ESS	32.05a-e	26.97c-e	24.46de	32.47a-d	27.92b-e	39.99a	30.64A\
Cima	23.89de	26.31c-e	24.47de	21.32e	38.41ab	22.44de	26.14B\
Backpack sprayers	21.94de	31.49a-e	30.60a-e	21.92de	28.39b-e	35.41a-c	28.29AB\
mean	25.96B	28.26AB	26.51B	25.24B	31.58A	32.61A	

In each season, means of each of concentration of each spraying material and spraying machine type or their interaction having the same letter (s) are not significantly different at 5% level.

spray and invariably improves spray efficiency (Samuel Appah et al., 2019). In this trend, Abscisic acid application has increased the fruit quality may be due to enhancing the expression of *Chs, Chi, Dfr* and *Ufgt* genes in the anthocyanin biosynthesis pathway, and the coordinating factors *VvmybA1*, a putative regulatory gene of anthocyanin biosynthesis of grape (Jeong et al., 2004 and Ban et al., 2003). It was moreover detailed that abscisic acid hastens the initiation of sugar accumulation, by stimulating the uptake and storage of sugars by berries (Davies and Böttcher, 2009).

These results are in harmony with those obtained by Giuseppe Ferrara et al. (2013) they found that, either the application of S-ABA at 400 mg/L one or four week after veraison positively affected the berry skin color, enhanced coloration of the berries. In this tendency Aly et al., (2020) They stated that, abscisic acid at 200mg/l reducing sugars, anthocyanin content

TABLE 8. Effect of machine type and material type with different concentration on firmness Newton of Crimson seedless grapes during 2017-2018 seasons.

Material type / Machine	Ethephon(ppm)			Abscisic acid(ppm)			mean
	500	1000	2000	500	1000	2000	
2017 season							
Electrostatic ESS	0.397a	0.339b-f	0.331c-f	0.358b-d	0.323d-g	0.312fg	0.343A\
Cima	0.350b-e	0.332c-f	0.317e-g	0.341b-f	0.320d-g	0.288g	0.325B\
Backpack sprayers	0.362a-c	0.321d-g	0.305fg	0.376ab	0.354b-e	0.307fg	0.338A\
mean	0.370A	0.331B	0.318BC	0.358A	0.333B	0.302C	
2018 season							
Electrostatic ESS	0.387a	0.317c	0.314c	0.384a	0.320c	0.322c	0.341A\
Cima	0.368ab	0.315c	0.305c	0.348b	0.321c	0.307c	0.327B\
Backpack sprayers	0.373ab	0.318c	0.309c	0.359b	0.320c	0.308c	0.331B\
mean	0.376A	0.317C	0.309C	0.364B	0.320C	0.312C	

In each season, means of each of concentration of each spraying material and spraying machine type or their interaction having the same letter (s) are not significantly different at 5% level.

TABLE 9. Effect of machine type and material type with different concentration on Anthocyanin (mg/100g) of Crimson seedless grapes during 2017-2018 seasons.

Material type / Machine	Ethephon(ppm)			Abscisic acid(ppm)			Mean
	500	1000	2000	500	1000	2000	
2017 season							
Electrostatic ESS	41.11d-f	41.54b	41.55b	41.29cd	41.55b	41.90a	41.49AB\
Cima	40.83g	41.43bc	41.95a	40.96fg	42.00a	42.04a	41.53A\
Backpack sprayers	40.85g	41.18de	41.85a	40.96e-g	41.95a	42.04a	41.47B\
Mean	40.93E	41.38C	41.79B	41.07D	41.83B	41.99A	
2018 season							
Electrostatic ESS	41.10gh	41.58de	41.58de	41.52ef	41.62c-e	41.83a-c	41.54A\
Cima	40.85i	41.51ef	41.76cd	40.91hi	41.99ab	42.04a	41.51AB\
Backpack sprayers	40.81i	41.31fg	41.99ab	40.90hi	41.77b-d	41.99ab	41.46B\
mean	40.92E	41.46C	41.78B	41.11D	41.79B	41.95A	

In each season, means of each of concentration of each spraying material and spraying machine type or their interaction having the same letter (s) are not significantly different at 5% level.

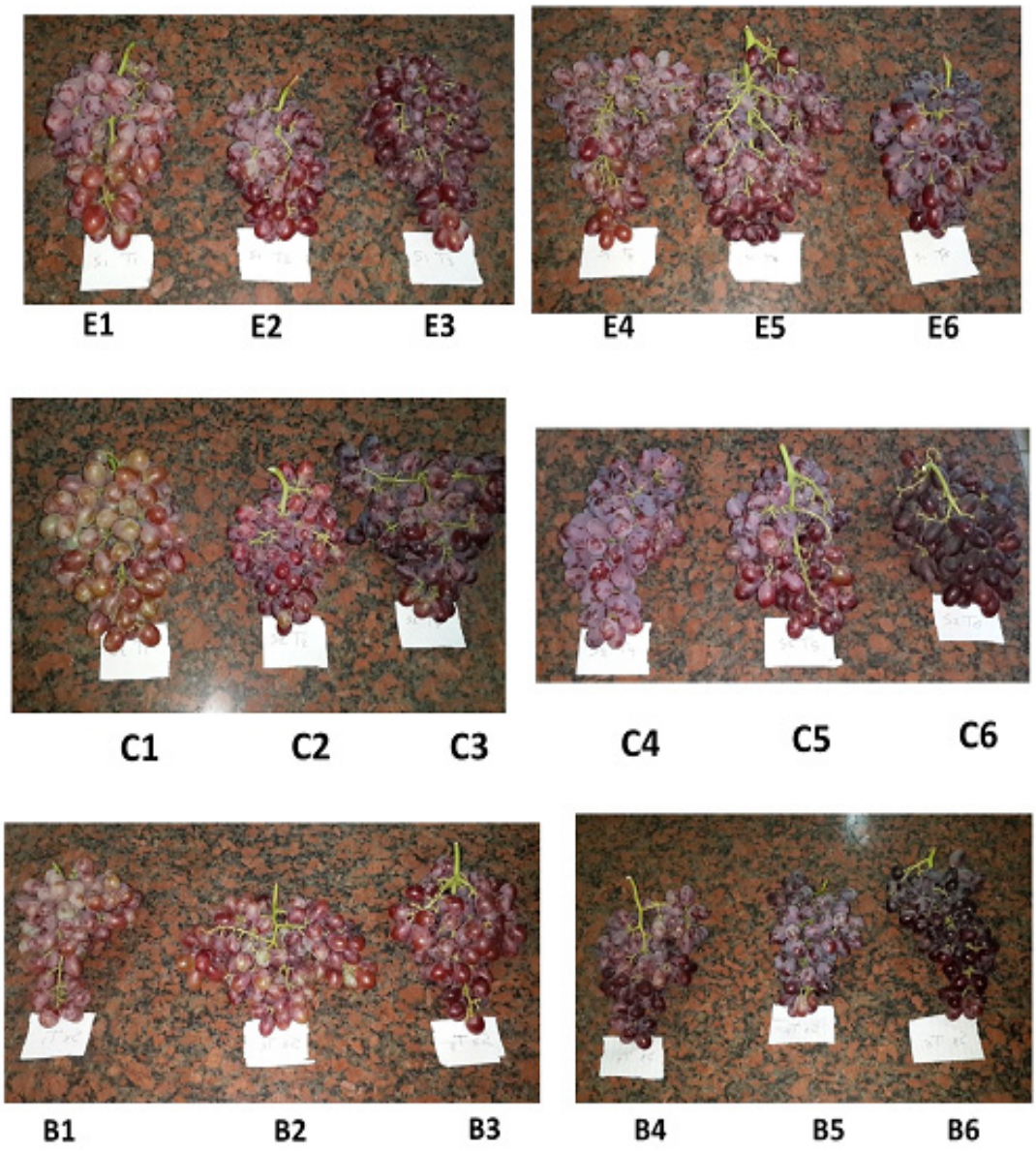

Fig. 3. Effect of machine type and material type with different concentration on the skin-coloring of Crimson seedless grapes.

*E1=ESS Ethephon 500 ppm, E2= ESS Ethephon 1000 ppm, E3= ESS Ethephon 2000 ppm, E4= ESS Abscisic acid 500 ppm, E5=ESS Abscisic acid 1000 ppm, E6=ESS Abscisic acid 2000 ppm, C1=Cima Ethephon 500 ppm, C2= Cima Ethephon 1000 ppm, C3=Cima Ethephon 2000 ppm,C4= Cima Abscisic acid 500 ppm, C5= Cima Abscisic acid 1000 ppm, C6= Cima Abscisic acid 2000 ppm, B1= Backpack sprayers Ethephon 500 ppm, B2= Backpack sprayers Ethephon 1000 ppm, B3= Backpack sprayers Ethephon 2000 ppm, B4= Backpack sprayers Abscisic acid 500 ppm, B5= Backpack sprayers Abscisic acid 1000 ppm, C6= Backpack sprayers Abscisic acid 2000 ppm,

and vitamin C content as compared with the control treatment.

Conclusion and Recommendation

The use of spraying machine ESS and Cima increased the efficiency of the spray solution as it increased fruit quality represented by TSS/acid ratio and Anthocyanin content. In this trend, 2000ppm of Abscisic acid gave the significant highest values of Anthocyanin content followed by 1000ppm ABA and 2000ppm Ethephon, while there was no significant differential effect of them on TSS/acid ratio. On the other hand, the firmness decreased when spraying by 2000ppm and 1000ppm from Ethephon and Abscisic acid. Therefore, it can be recommended to get the best color and TSS/acid ratio for berry of Crimson seedless grape with spraying 1000ppm Abscisic acid or 2000ppm Ethephon by ESS or Cima spray machines.

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Conflicts of interest

There were no conflicts of interest during this work

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تحسين جودة ثمار العنب الكريمسون اللابذري بالرش الورقي للإثيفون وحمض الابسيسيك باستخدام ثلاثة أنواع من الآلات

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أجريت هذه الدراسة بهدف تحسين جودة ثمار العنب صنف كريمسون اللابذري والمطعوم على أصل ريختر ١١٠ بعمر ٤ سنوات ومزروع بأرض رملية تروى بالتنقيط بمنطقة القطا، محافظة الجيزة، مصر وذلك خلال موسمي ٢٠١٨/٢٠١٧. تم تصميم التجربة في قطع منشقه حيث استخدم ثلاثة آلات رش (إلكتروستاتيك – شيما – الرشاشة الظهرية) في القطع الرئيسية وستة محاليل رش (٥٠٠ جزء في المليون أثيفون – ١٠٠٠ جزء في المليون أثيفون – ٢٠٠٠ جزء في المليون أثيفون - ٥٠٠جزء في المليون حمض ابسيسيك – ١٠٠٠ جزء في المليون حمض ابسيسيك – ٢٠٠٠ جزء في المليون حمض ابسيسيك) في القطع الفرعية وذلك في مرحلة نزول الماء للحبات. وقد أظهرت النتائج أن استخدام الرشاشة الإلكتروستاتيك والشيما زاد من جودة الثمار خصوصا نسبة المواد الذائبة الكلية/الحموضة ومحتوى الحبات من الأنثوسيانين. أعطى الرش ب ٢٠٠٠ جزء في المليون من حمض الأبسيسيك أعلى قيم معنوية لمحتوى الأنثوسيانين تليها ١٠٠٠ جزء في المليون حمض الأبسيسيك و٢٠٠٠ جزء في المليون أيثيفون، بينما لم يكن هناك تأثير معنوي لهم على نسبة المواد الصلبة الذائبة الكلية / الحموضة. ومن ناحية أخرى، انخفضت صلابة الحبات عند الرش بمقدار ٢٠٠٠ جزء في المليون و١٠٠٠ جزء في المليون من حمض الأبسيسيك والأثيفون. لذلك، يمكن التوصية للحصول على أفضل نسبة لون ونسبة مواد صلبة ذائبة كلية/الحموضة لحبات العنب الكريمسون اللابذري يتم الرش بحمض الأبسيسيك ١٠٠٠ جزء في المليون أو الأثيفون ٢٠٠٠ جزء في المليون بواسطة الرشاشة إلكتروستاتيك او شيما وذلك عند نزول الماء للحبات.