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Effect of Some Preharvest Treatments on the Incidence of Waterberry Disorder and on Fruit Quality Characteristics of "Thompson Seedless" Table Grapes

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Abstract: The present study was conducted during 2015 and 2016 growing seasons, by using 6-years-old Thompson seedless grapevines to investigate the role of some Preharvest sprayed compounds on the incidence of waterberry physiological disorders and on the enhancement of cluster and berry characteristics of grapes. A total of 9 treatments included the control (water spray), GA_3 (20 ppm), lisophos (200 ppm), $CaCl_2$ (0.5%), molybdenum (100 ppm), GA_3 plus either $CaCl_2$ or molybdenum and lisophos plus either $CaCl_2$ or molybdenum. Treatments were applied twice during berry development, directly after fruit set and one month later during the two growing seasons. The results proved that all treatments significantly reduced waterberry disorder. In addition, berry-treated with lisophos plus either $CaCl_2$ or molybdenum lowered ion leakage percentage. Furthermore, all treatments enhanced cluster and berry characteristics such as cluster weight, berry weight and diameter. Both GA_3, $CaCl_2$ and combinations treatments decreased berry TSS, total sugars and increased berry acidity. Lisophos and molybdenum treatments increased TSS, total sugars, berry carotene contents and decreased berry acidity and berry chlorophylls as compared with GA_3 or $CaCl_2$ treatments but similar to control treatment. GA_3 treatment increased berry nitrogen contents. On the other hand, molybdenum treatment decreased berry nitrogen contents but increased berry molybdenum contents. Moreover, $CaCl_2$ treatment increased berry calcium contents. Lisophos treatment increased berry potassium, calcium and molybdenum contents.

Key words: Grapes ・ Lisophos ・ $CaCl_2$ ・ GA_3 ・ Quality ・ Waterberry

INTRODUCTION

Waterberry is a physiological disorder facing the production of grapes around the world. Waterberry disorder is known by many names such as bunch stem necrosis (BSN), shanking and withering [1]. The conditions that cause waterberry disorder included grapevine over-cropping, hormonal and imbalance nutrition, pedicel necrosis and tyloses [2, 3]**.** The symptoms of disorder included soft berries, berries lack of sugars, color, flavor and shipping quality.

Gibberellic acid (GA) is a plant growth regulator promoting growth and positively regulates many processes. The impact of GA_3 treatment on the grape cluster depends on the concentration and development stage [4]. Theiler and Coombe [5] summarize the positive roles of GA_3 on cluster and berries of grapes included remained peduncle healthy, increased metaxylem area, pedicel thickening, sink strength, decreased water loss and integrity maintaining and inhibited ethylene production. Hifny [6] and Pickering [7] reported that the application of GA_3 after fruit set reduced the incidence of physiological disorders of grapes such as BSN. The application of GA_3 during fruit set increased berry weight, berry size, cluster weight and leads to a thicker berry skin of "Thompson seedless" grape berries [8-10].

Phospholipid and lysophospholipids have been reported as a potential growth regulator [11, 12]. The application of phospholipid such as lisophos preserved membrane health, maintained fruit firmness, reduced ion leakage of tissue and retarded fruit and leaf senescence [13, 14]. It thus appears that lisophos could have the potential to reduce waterberry disorder in "Thompson seedless" grape berries by maintaining membrane and cell wall integrity and inhibit the activity of phospholipase D (leads to membrane breakdown) [15]. The application of lysophospholipids such as LPE enhanced fruit quality of "Thompson seedless" table grapes [16].

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Calcium is a key plant nutrient that has a significant role in cell functions included reducing softening and senescence of fruits [17]. Calcium deficiency could increase cell wall membrane permeability and led to increase the activity of enzymes like pectin methyl esterase and polygalactourenase in fruit, which reflect on causes many physiological disorders of fruits such as waterberry in grapes, bitter pit in apple and crock spot in pears [18-20]. Preharvest application of $CaCl_2$ to the grape bunch improved cluster and berry characteristics of "Thompson seedless" table grapes, in addition, increased berry calcium contents [21-23].

Molybdenum is an essential trace element for plant growth, nitrogen assimilation enzymes such as nitrate reductase which participate directly or indirectly with nitrogen metabolism [24]. Thus, the accumulation of nitrogen in plant tissue has been shown to cause necrosis [25]. The application of foliar sprays sodium molybdate significantly increased yield, uniform berry size and development, while increased vine molybdenum status [26]. Molybdenum deficiency in grapevines has recently been suggested as the primary cause of a bunch development disorders called early bunch stem necrosis (EBSN) and millerandage [27, 28].

According to the above discussion, the aim of this study was to investigate the effect of preharvest spray of GA_3, lisophos, $CaCl_2$ and molybdenum on waterberry physiological disorder and cluster and berry characteristics at harvest of "Thompson seedless" table grapes cultivar.

MATERIALS AND METHODS

Experiment Description: Six-years-old "Thompson seedless" grape vines grown on own roots, were selected for conducting this experiment during the two growing seasons 2015 and 2016, in a private orchard at Elboustan region, Behira governorate, Egypt. Soil type was sandy and drip irrigation system was adopted. Y shape trellis system was used and cane pruning was used by retaining 12-15 Eye / cane. The vines in this study were selected on the basis of vine growth uniformity. The trial was designed as a randomized complete block design (RCBD), the following treatments were carried out with four replicates (9 treatments * 2 spray * 4 replicates):

- Water only (Control).
- 20 mg/L Gibberellic acid (GA_3).
- 200 mg/L Lisophos (Lysophospholipid 70%).
- 0.5% $CaCl_2$.
- 100 mg/L Molybdenum (Sodium Molybdate).
- GA_3+ $CaCl_2$.
- GA_3+ Molybdenum.
- Lisophos+ $CaCl_2$.
- Lisophos+ Molybdenum.

The surfactant Topfilm was added to all treatments at 0.5 cm/ L. The experimental vines received the treatments at two application times, the first spray was applied directly after fruit set (5, 10 May) during 2015 and 2016 seasons, respectively while the second was applied one month later in both seasons of study by using a hand sprayer to the point of runoff.

Cluster and Berry Physical and Chemical Characteristics: At harvest, three clusters from each replication were picked and berries were removed from each bunch, 100-berry sample was randomly collected from each replicate to determine the following physical and chemical characteristics: Number of waterberry/ 100 berries (%), cluster weight (g), cluster length (cm), Electrolyte leakage of cluster pedicels (%), Electrolyte leakage of cluster laterals (%) was measured according to a standard procedure [13], 100 berry weight (g), 100 berry volumes (cm^3), berry diameter (cm), berry length (cm). On the other hand, in juice of berries, total soluble solids (TSS) were determined by hand refractometer, titratable acidity (as tartaric acid) was determined according to A.O.A.C [29], the ratio between TSS / acidity was calculated. Total sugars were determined according to Smith [30], Chlorophyll a, b and carotenes were determined according to Lichtenthaler and Wellburn [31].

Nitrogen (N), Potassium (K), Calcium (Ca) and Molybdenum (Mo) in Berries at Harvest: The modified micro-kjeldahl apparatus of Parnars and Wagner as described by Jones *et al*. [32] was employed for total nitrogen (mg/ L) determination according to A.O.A.C [33]. Total potassium (mg/ L) were estimated Flamephotometrically using Lenway Flamephotometer model Corning 400 according to Peterburgski [34]. Total calcium and molybdenum (mg/ L) were estimated using atomic absorption spectrophotometer (A Perkin-Elmer, Model 2380.USA) according to the methods of Chapman and Pratt [35].

Assessment of Waterberry Development after two Days of Harvest: To investigate the effect of different treatments on waterberry development after harvest, three clusters from each replicate was kept at ambient temperature (20 ± 2°C) for two days, electrolyte leakage of cluster pedicels (%) and electrolyte leakage of cluster laterals (%) were measured according to a standard procedure [13].

Statistical Analysis: The experiment design was randomized complete block design with four replications. Data were subjected to analysis of variance using statistical analysis system [36]. The least significant test was used to compare among means at 0.05 levels according to Sndecor and Cochran [37].

RESULTS

Preharvest foliar application of all sprayed chemical significantly reduced waterberry disorder percentage as compared with control (Figure 1). The lowest percentage of waterberry disorders was obtained with lisophos at 200 ppm plus either $CaCl_2$ at 0.05% or molybdenum at 100 ppm and gibberellic acid at 10 ppm plus molybdenum at 100 ppm followed by individual treatments as compared with control treatment in 2014 and 2015 seasons.

Regarding electrolyte leakage, the data in (Table 1) showed that "Thompson seedless" clusters treated with lisophos plus $CaCl_2$ and lisophos plus molybdenum had lower ion leakage percentage as compared to control especially in the second season 2016. Moreover, there were no significant differences between GA_3 and control for electrolyte leakage of laterals, especially in the second season. The data in (Table 1) showed that Preharvest application of GA_3 alone or in combination with $CaCl_2$ or molybdenum significantly increased cluster length as compared with other treatments and control in both seasons. Moreover, cluster weight (g) was significantly increased with preharvest foliar application with different treatments in both seasons (Table 1). Maximum cluster weight was recorded by GA_3 treatments whether alone or in combination with $CaCl_2$ or molybdenum. Furthermore, Preharvest applications of lisophos, $CaCl_2$, molybdenum and in combination were greater increased cluster weight as compared with control treatments but lower than GA_3 treatments.

The data in (Table 2) indicated to a significant increase in berry weight and berry volume in both seasons of study by all foliar chemical sprayed compared to the control. The highest berry weight and volume were obtained with GA_3 treatments followed by molybdenum, lisophos plus $CaCl_2$ and lisophos plus molybdenum. With regard to berry length at harvest, the data in (Table 2) showed that GA_3 treatments caused a significant increase in berry length as compared with the control in both seasons. On the other hand, there were no significant change was found in berry length between lisophos, $CaCl_2$ and molybdenum treatments. The changes in berry diameter in response to various treatments at harvest provided evidence that berry diameter increased by GA_3 application whether applied alone or incorporated with either molybdenum or $CaCl_2$. On the other hand, no significant change was found in berry diameter by other treatments relative to the control in both seasons.

With regard to TSS in response to Preharvest treatments were reported in (Table 3). The data illustrated that there were no significant differences between lisophos, molybdenum and control treatment in berry TSS. On the other hand, both GA_3 and $CaCl_2$ treatments reduced TSS% as compared with other treatments and control. Similar trend of results was obtained with fruit total sugars. Changes in fruit acidity in response to Preharvest applied treatments were reported in. The data showed that GA_3-treated berry grapes had higher acidity content than that of control and other treatments. On the other hand, the application of lisophos, molybdenum and lisophos plus molybdenum resulted in lower acidity as

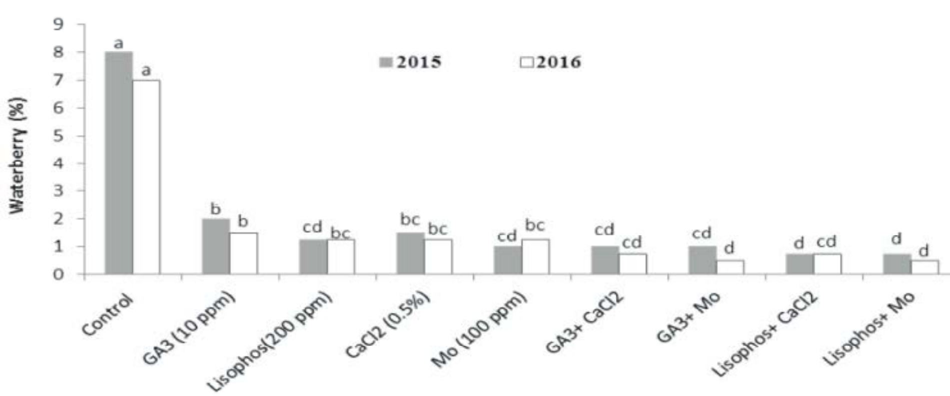

Fig. 1: Effect of preharvest treatments on waterberry physiological disorder at harvest of "Thompson seedless" grapes.

Table 1: Effect of preharvest applied treatments on cluster physical characteristics of "Thompson seedless" grapes at harvest during 2015 and 2016 seasons.

	Electrolyte leakage of cluster laterals (%)		Electrolyte leakage of cluster pedicels (%)		Cluster length (cm)		Cluster weight (g)	
Treatments	2015	2016	2015	2016	2015	2016	2015	2016
Control	36.68[a]	34.46[a]	48.47[a]	50.4[a]	17.95[c]	16.9[f]	406.66[f]	399.5[d]
GA_3 10 ppm	33.73[b]	33.43[ab]	44.43[b]	45.34[b]	23.57[a]	23.88[ab]	578.43[a]	593.25[a]
Lisophos 200 ppm	28.29[c]	30.12[bc]	41.77[de]	40.44[d]	18.98[c]	17.25[ef]	427.81[e]	422.5[c]
$CaCl_2$ 0.5%	29.1[c]	30.4[bc]	43.27[c]	42.44[c]	18.55[c]	18.25[c]	445.49[d]	422.75[c]
Mo 100 ppm	34.09[b]	33.25[ab]	43.44[bc]	42.27[c]	19[c]	17.55[de]	459.43[c]	454.25[b]
GA_3+ $CaCl_2$	27.38[cd]	27.2[cd]	41.58[de]	41.95[c]	22.55[ab]	24.25[a]	562.31[b]	593.5[a]
GA_3+ Mo	27.36[cd]	27.83[cd]	42.35[cd]	42.25[c]	21.88[b]	23.45[b]	555.2[b]	590.5[a]
Lisophos+ $CaCl_2$	26.14[d]	25.18[d]	41.74[de]	40.49[d]	18.38[c]	18.15[cd]	459.72[c]	463[b]
Lisophos+ Mo	27.64[cd]	25.7[d]	41.19[e]	40.11[d]	19.1[c]	18[cd]	465.54[c]	458.25[b]

Values, within a column, of similar letter (s) are not significantly different according to LSD (P = 0.05).

Table 2: Berry physical characteristics of "Thompson seedless" grapes at harvest as influenced by preharvest treatments during 2015 and 2016 seasons.

	Weight of 100 berries (g)		Volume of 100 berries (cm^3)		Berry length (cm)		Berry diameter (cm)	
Treatments	2015	2016	2015	2016	2015	2016	2015	2016
Control	188.17 [e]	199.48 [d]	197.12 [f]	207.85 [e]	1.59 [e]	1.57 [f]	1.33 [d]	1.31 [d]
GA_3 10 ppm	304.03 [a]	303.38 [a]	314.51 [a]	313.65 [a]	1.94 [ab]	2.05 [a]	1.66 [a]	1.7 [a]
Lisophos 200 ppm	222.8 [d]	235.13 [c]	232.34 [d]	247.23 [d]	1.69 [d]	1.71 [cd]	1.39 [c]	1.36 [c]
$CaCl_2$ 0.5%	241.85 [b]	240.68 [bc]	250.16 [c]	249.13 [d]	1.66 [de]	1.64 [e]	1.4 [c]	1.35 [cd]
Mo 100 ppm	228.88 [cd]	247.13 [b]	234.13 [d]	257.4 [c]	1.79 [c]	1.76 [c]	1.36 [cd]	1.36 [cd]
GA_3+ $CaCl_2$	295.85 [a]	299.5 [a]	297.7 [b]	302.38 [b]	1.88 [bc]	1.95 [b]	1.59 [b]	1.6 [b]
GA_3+ Mo	298.25 [a]	303.38 [a]	303.73 [b]	315.23 [a]	1.99 [a]	2.05 [a]	1. 68 [a]	1.64 [b]
Lisophos+ $CaCl_2$	221.06 [d]	244.2 [b]	222.32 [e]	259.95 [c]	1.69 [d]	1.7 [cd]	1.34 [d]	1.33 [cd]
Lisophos+ Mo	233.55 [bc]	244.98 [b]	239.41 [d]	252.8 [cd]	1.7 [d]	1.66 [de]	1.33 [d]	1.33 [cd]

Values, within a column, of similar letter (s) are not significantly different according to LSD (P = 0.05).

Table 3: Effect of various preharvest treatments on berry chemical characteristics of "Thompson seedless" grapes at harvest during 2015 and 2016 seasons.

	TSS%		Acidity%		TSS/ acidity ratio		Total Sugars%	
Treatments	2015	2016	2015	2016	2015	2016	2015	2016
Control	19.33 [a]	18.65 [a]	0.83 [bcd]	0.82 [bc]	23.3 [a]	22.82 [b]	17.25 [a]	17.5 [a]
GA_3 10 ppm	16.63 [e]	16.43 [c]	0.91 [a]	0.88 [a]	18.28 [d]	18.65 [f]	14.23 [e]	15.13 [c]
Lisophos 200 ppm	17.03 [d]	18.58 [a]	0.86 [c]	0.84 [b]	19.81 [c]	22.22 [c]	14.73 [d]	17.1 [a]
$CaCl_2$ 0.5%	18.38 [c]	17.95 [b]	0.85 [bc]	0.83 [b]	21.62 [b]	21.63 [d]	16.23 [c]	16.6 [b]
Mo 100 ppm	19.05 [ab]	18.7 [a]	0.84 [bcd]	0.81 [c]	22.68 [a]	23.17 [a]	16.95 [ab]	17.18 [a]
GA_3+ $CaCl_2$	16.4 [e]	16.23 [c]	0.93 [a]	0.89 [a]	17.69 [d]	18.34 [f]	13.98 [e]	14.93 [c]
GA_3+ Mo	16.6 [e]	16.4 [c]	0.9 [a]	0.84 [b]	18.41 [d]	19.7 [e]	14.28 [e]	15.1 [c]
Lisophos+ $CaCl_2$	18.85 [b]	18.1 [b]	0.82 [cd]	0.81 [c]	23 [a]	22.46 [bc]	16.8 [b]	16.63 [b]
Lisophos+ Mo	19.03 [ab]	18.8 [a]	0.82 [cd]	0.81 [c]	23.35 [a]	23.29 [a]	16.85[b]	17.28 [a]

Values, within a column, of similar letter (s) are not significantly different according to LSD (P = 0.05).

compared with GA_3 treatments but similar to control treatment. There was a significant increase in TSS/ acidity ratio as a result of using lisophos, molybdenum and lisophos plus molybdenum treatments as compared with GA_3 treatments but similar to control treatment. Moreover, GA_3 treatments reduced TSS/ acidity ratio as compared with control treatment.

The data in (Table 4) showed that GA_3 plus $CaCl_2$-treated berry of Thompson seedless grapes possessed the highest chlorophyll a content followed by GA_3 and GA_3 plus molybdenum in both seasons. $CaCl_2$ alone caused a significant increase in chlorophyll a to control treatments. Moreover, there were no significant differences among lisophos, molybdenum and lisophos plus molybdenum related to control. The data in (Table 4) proved that berry treated with GA_3 plus $CaCl_2$ possessed the highest chlorophyll b. on the other hand, lisophos plus molybdenum treated berry possessed the lowest chlorophyll b content. With regard to berry carotene content at harvest, the data in Table 4 revealed that berry

Table 4: Effect of various preharvest treatments on berry peel chlorophyll a, chlorophyll b and carotene of "Thompson seedless" grapes at harvest during 2015 and 2016 seasons.

	Chlorophyll a (mg/ 100 g)		Chlorophyll b (mg/ 100 g)		Carotene (mg/ 100 g)	
Treatments	2015	2016	2015	2016	2015	2016
Control	1.73 e	1.73 e	0.698 bc	0.713 bc	0.978 cd	0.988 cd
GA_3 10 ppm	2.34 b	2.34 b	0.718 b	0.728 b	0.8 f	0.808 f
Lisophos 200 ppm	1.75 de	1.75 de	0.675 cd	0.683 cd	1.01 b	1 abc
$CaCl_2$ 0.5%	1.76 d	1.76 d	0.693 bc	0.685 cd	0.968 d	0.983 d
Mo 100 ppm	1.75 de	1.76 d	0.69 bc	0.693 bcd	0.995 bc	1.01 a
GA_3+ $CaCl_2$	2.38 a	2.37 a	0.833 a	0.828 a	0.733 g	0.733 g
GA_3+ Mo	2.18 c	2.22 c	0.643 d	0.663 d	0.85 e	0.863 e
Lisophos+ $CaCl_2$	1.75 de	1.75 de	0.685 bc	0.703 bc	0.99 bcd	0.993 bcd
Lisophos+ Mo	1.74 de	1.75 de	0.595 e	0.683 cd	1.06 a	1.01 ab

Values, within a column, of similar letter (s) are not significantly different according to LSD (P = 0.05).

Table 5: Nitrogen (N), Potassium (K), Calcium (Ca) and Molybdenum (Mo) concentration of "Thompson seedless" table grapes at harvest as affected by various preharvest treatments.

	N (mg/ L)		K (mg/ L)		Ca (mg/ L)		Mo (mg/ L)	
Treatments	2015	2016	2015	2016	2015	2016	2015	2016
Control	1011.4 d	1011.88 d	1032.3 e	1230 e	1103.4 e	1074.9 c	0.08 f	0.09 c
GA_3 10 ppm	1091.56 a	1090.7 a	1261.3 d	1257.1 d	1156.4 bc	1152.1 b	0.11 d	0.113 b
Lisophos 200 ppm	994.8 e	991.43 e	1279.03 c	1273.93 c	1166.2 b	1157.9 ab	0.12 c	0.115 b
$CaCl_2$ 0.5%	964.8 g	950.33 g	1285.3 b	1280.1 b	1160.4 bc	1151.2 ab	0.11 e	0.098 c
Mo 100 ppm	925.03 h	924.8 h	1296.6 a	1292.3 a	1160.38bc	1156.1 ab	0.15 a	0.16 a
GA_3+ $CaCl_2$	1085.4 b	1083.25 b	1278.93 c	1272.6 c	1191.15 a	1170.2 a	0.11 d	0.113 b
GA_3+ Mo	971.3 f	963.3 f	1288.13 b	1289.55 a	1166.15 b	1159.75 b	0.15 a	0.16 a
Lisophos+ $CaCl_2$	1036.5 c	1040.28 c	1294.3 a	1290.63 a	1193.3 a	1163.2 a	0.12 c	0.12 b
Lisophos+ Mo	970.03 fg	964.13 f	1295.1 a	1289.9 a	1150.3 d	1139.38 b	0.14 b	0.165 a

Values, within a column, of similar letter (s) are not significantly different according to LSD (P = 0.05).

treated with lisophos, molybdenum and lisophos plus either molybdenum or $CaCl_2$ increased berry carotene contents compared with GA_3-treatments but similar to control in both seasons. On the other hand, GA_3 and $CaCl_2$ treated berry grapes decreased carotene content as compared with control and other treatments.

Regarding berry mineral contents at harvest, the data in (Table 5) indicated that spraying berry Thompson seedless grapevines with GA_3 at 10 ppm directly after fruit set and one month later significantly increased berry nitrogen and potassium contents. On the contrary, molybdenum foliar spray at 100 ppm twice during berry development decreased berry nitrogen contents and increased berry potassium, calcium and molybdenum contents. Furthermore, foliar application with $CaCl_2$ increased berry calcium contents. Moreover, lisophos treatment alone or in combination with either $CaCl_2$ or molybdenum in one formulation significantly decreased berry nitrogen content and increased berry potassium, calcium, molybdenum as compared with control treatment in both seasons.

The data presented in Table 6 illustrates the effect of different Preharvest applied treatments on waterberry development after keeping clusters at ambient temperature for two days. The data indicated that all treatments decreased the percentage of waterberry as compared with control treatment in a consistent manner in both seasons. The incorporation of either $CaCl_2$ or molybdenum with lisophos solution resulted in a significant reduction in waterberry percentage. The data in Table 6 showed that the greatest berry leakage was obtained with non-treated berry (control). On the other hand, all treatments reduced the percentage of electrolyte leakage. Moreover, the incorporation of $CaCl_2$ or molybdenum with either lisophos or GA_3 resulted in a significant decrease in electrolyte leakage percentage since they all had less electrolyte leakage percentage as compared with the control treatment.

Table 6: Effect of preharvest treatments on the development of waterberry disorder, electrolyte leakage of cluster laterals and electrolyte leakage of cluster pedicels after two days on shelf (at ambient temperature) during 2015 and 2016 seasons.

	Waterberry%		Electrolyte leakage of cluster laterals (%)		Electrolyte leakage of cluster pedicels (%)	
Treatments	2015	2016	2015	2016	2015	2016
Control	9.75 [a]	9 [a]	40.56 [a]	40.94 [a]	52.95 [a]	51.11 [a]
GA_3 10 ppm	2.5 [b]	2 [b]	35.7 [b]	33.77 [b]	49.7 [b]	46.23 [b]
Lisophos 200 ppm	1.75 [bc]	1.25 [bc]	31 [d]	32.47 [c]	45.6 [e]	40.21 [f]
$CaCl_2$ 0.5%	1.5 [c]	1 [c]	32.45 [c]	33.62 [b]	48.04 [c]	42.48 [c]
Mo 100 ppm	1.25 [c]	0.75 [c]	35.5 [b]	28.75 [e]	48.3 [c]	41.1 [e]
GA_3+ $CaCl_2$	1.25 [c]	1 [c]	27.7 [fg]	28.23 [f]	46.3 [d]	41.84 [d]
GA_3+ Mo	1.25 [c]	1 [c]	26.9 [g]	27.72 [g]	46.3 [d]	42.7 [c]
Lisophos+ $CaCl_2$	1.25 [c]	0.75 [c]	28.4 [ef]	26.9 [h]	43.84 [f]	40.3 [f]
Lisophos+ Mo	1 [c]	0.5 [c]	29.4 [e]	30.48 [d]	43.93 [f]	40.26 [f]

Values, within a column, of similar letter (s) are not significantly different according to LSD (P = 0.05).

DISCUSSION

The decrease in waterberry disorders of Thompson seedless grapes (Figure 1) especially by lisophos might be attributed to its influence on maintaining the membrane integrity and slowing the breakdown of cell walls which reflects on reducing the physiological disorders [13, 14, 38]. Furthermore, Theiler and Coombe [5] found that the application of GA_3 to the peduncle during fruit set maintained healthy peduncle, significantly increased the area of the metaxylem and increased peduncle thickening. Aforementioned, the effects of GA_3 on peduncle characteristics reflects on the passage of water and elements and on the sink strength potential of berry against vegetative growth, which reflects on reducing waterberry disorders. The positive effect of $CaCl_2$ on reducing waterberry disorder might be attributed to stabilized cell membranes and protect against cell wall degradation which reflected on preventing physiological disorders attributed to calcium deficiency [39, 40]. Molybdenum application plays an important role in berry formation and nitrogen assimilation which reflected on reducing bunch physiological disorders [27, 28].

The application of phospholipid and lysophospholipids such as lisophos preserving membrane health which reflects on reducing the leakage of electrolytes [13]. In the current study, lisophos spray showed positive effects on reducing berry leakage electrolytes (Table 1). The results of the present study agreed with those obtained by Ryu *et al*. [15], Zeinab *et al*. [38] and Farag and Attia [14]. $CaCl_2$ spray also decreased berry leakage electrolytes as compared with the control (Table 1). The positive effect of $CaCl_2$ on reducing berry leakage could be attributed to their effect on stabilization and rigidity of cell membranes and walls [41].

Preharvest treatments with GA_3 enhanced cluster and berry characteristics of Thompson seedless grapes at harvest [10, 23, 42]. In the present study, GA_3 spray showed positive effects on cluster and berry characteristics (Table 1 and 2). These results could be attributed to a direct effect of GA_3 on promoting growth by stimulating cell division and cell enlargement, increasing plasticity of the cell wall, reducing water potential of the cell and enhanced sink strength [43]. Marzouk and Kassem [23] and Alrashdi *et al*. [10] reported that sprayed Thompson seedless with GA_3 after fruit set enhanced cluster and berry characteristics such as cluster weight, berry weight, berry size and berry diameter. Hong *et al*. [16] reported an increase in Thompson seedless grape vine by spraying LPE. The positive effect of lisophos on berry physical characteristics might be attributed to their influence on maintaining membrane integrity and retarding leave senescence which reflect on photosynthesis [11]. $CaCl_2$ spray showed positive effects on cluster and berry properties [10, 23]. Meanwhile, molybdenum spray showed positive effects on yield of grapevine [26, 28].

The present study showed an overall enhancement in t he berry chemical quality by applied chemicals. The data in (Table 3) indicated that GA_3 and $CaCl_2$ treatments reduced berry TSS and berry total sugars. Both GA_3 and $CaCl_2$ delayed berry ripening. These results were in harmony with the findings of other researchers [44, 45, 46]. On the other hand, both GA_3 and $CaCl_2$ increased berry acidity as compared with control and other treatments [10, 23]. Furthermore, lisophos and molybdenum treatments showed no significant effect on TSS, total sugars and berry acidity as compared with control treatment but higher than GA_3 and $CaCl_2$.

The positive effect of lisophos on berry pigments was previously reported [16, 47, 48]. These positive effects might be attributed to enhanced ethylene production [49], stimulation of ripening and enhance carotenoid accumulation [50]. Also, molybdenum treatment enhanced berry formation and development [28]. On the other hand, the current study showed that both GA_3 and $CaCl_2$ treatments retarded ripening of Thompson grapes. These results are in harmony with [10, 23] on grapes and [51] on pomegranates.

The data in (Table 5) indicated that GA_3 treatment increased nitrogen and potassium berry contents. The results suggest an improvement of the uptake of these nutrients by the grapevine. These results were in agreement with Niu *et al*. [52]. Molybdenum treatment increased berry molybdenum content. These results were in agreement with the findings of Longbottom *et al*. [26]. $CaCl_2$ treatment increased berry calcium contents. These results are in agreement with other researchers Ghani *et al*. [53] on dragon fruit and Elmer *et al*. [54] on peach fruits. Lisophos treatment increased berry calcium, potassium and molybdenum contents. That may reflect on transport and absorption of mentioned minerals.

CONCLUSION

In general conclusion, this study provided evidences about the possibility of reducing the incidence of the physiological disorder known as waterberry in "Thompson seedless" grapevines by preharvest application of GA_3 plus either $CaCl_2$ or molybdenum and lisophos plus either $CaCl_2$ or molybdenum, while, enhancing cluster stems quality and berry characteristics.

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