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EFFECT OF IRRIGATION LEVELS WITH FOLIAR SPRAY OF SILICON, CALCIUM AND AMINO ACIDS ON "THOMPSON SEEDLESS" GRAPEVINES. I. YIELD AND FRUIT QUALITY

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ABSTRACT

This study was conducted during two growing seasons of 2016 and 2017 to evaluate the potential effects of different irrigation levels (30, 50 and 70% depleted of available soil water) after fruit set as well as four foliar applications of Control, Silicon spray at 1.5 g/L, Calcium nitrate at 1 g/L and Amino acids at 2 ml/L, which sprayed at 15-20 cm of shoot length and the second one after fruit set, then these were continuous every two weeks till veraison stage on yield and fruit quality of "Thompson seedless" (Vitis vinifera L.) grapevines grown in clay soil under flow irrigation system in El-Mahalla, Gharbia Governorate. The obtained results revealed that, vines irrigated at 30 and 50% depleted from soil available water showed a significant increase in yield and fruit quality compared with 70% depleted from soil available water. The results cleared that, all foliar applications enhancing in all clusters and berries quality, especially with the use of amino acids sprays on cluster (weight and length) and berry (length, diameter and weight of 100 berries). Vines irrigated with 30 and 50% depleted from soil available water in combined with amino acids sprays showed a significant increase in yield and cluster characters (weight, length and number) and berry characters in terms of firmness, removal force, weight and volume of 100 berries. Moreover, foliar spray with calcium as well as silicon was very effective in reducing percentages of berries decay, cracking, wrinkled and berries shatter under all irrigation levels. However, the irrigation at 50% depleted from soil available water level increased berry SSC% and SSC/acid ratio and slightly decreased berry acidity%.

Conclusively, *the productivity of irrigation water was enhanced in vines irrigated at 50% depleted from soil available water, recommend it can reduce water irrigation by about 50% without losses in total yield with maintaining cluster and berry quality of "Thompson seedless" grape.*

Keywords: Irrigation, Silicon, Calcium, Amino acids, fruit quality, "Thompson seedless".

INTRODUCTION

Grapevine (*Vitis vinifera* L.) is the most important fruit crop in the world. It generally needs to select a good irrigation system because the use of training systems designed which resulted large leaves area for higher production, thus resulting a higher canopy water loss (Silva *et al.*, 2012). The importance of irrigation management as a key factor for the successful cultivation of table grapevines prompts; we need a new approach research for improving water management, aiming not only for environmentally sustainable agricultural practices but also for restraining water-related production costs (Martínez-de-Toda and Balda, 2013). Recently, Shahidian *et al.* (2016) summarized that, reducing irrigation by 70% from standard level had a negative effect on berry weight and sugar content. Various horticultural practices have been applied to alleviate the adverse effects of water deficit on normal plant functioning. For example, silicon applications (Meena *et al.*, 2014), amino acids sprays (Belal et al., 2016) and calcium foliar sprays (Upadhyaya *et al.*, 2011) improved plant growth under stress conditions.

Silicon is a natural element that found in most biological systems. Application of this element to some plants benefits it through mitigation of biotic and abiotic stresses moreover, it enhanced the nutrient uptake. Si nowadays used by some of the organic and biodynamic grape producers, since it is believed to be a more effective in increasing plant defense and fruit quality (Meunier *et al.,* 2011). Also, it helps in alleviating many stresses like drought, high temperature, salt, metal toxicity, nutrient imbalance (Habibi, 2015). Moreover, silicon fertilizers were showed several advantages of fruit quality, since it increased sugar content, enhanced hardness and pressure-resistance of grape and apple fruits also, increased vitamin C and protein content of nectarine fruit and some vegetable crops (Jia *et al.,* 2011). The alleviating of abiotic stresses effect using Si was suggested through several hypotheses viz.(a) enhanced photosynthetic activity (b) improved K/Na selectivity ratio (c) encourage enzyme activity and (d) increased the soluble substances concentrations of the xylem, which increased water absorption by plants also it was associated with increasing in antioxidant defense mechanism of plants Meena *et al.* (2014).

Amino acids are classified as organic nitrogenous compounds which play an important role in the synthesis of proteins involves a process in which ribosome catalyze the polymerization of amino acids (Davies, 1982). Amino acids have a high integrity with different metabolic bathes in plants which used to promote plant growth (Coruzzi and Last, 2000). It play an important role in mitigation of the drought stress resulting to reducing of irrigation needs as showed by Hattori *et al.* (2005) reported that, amino acids increases plants drought tolerance by maintaining plant water balance, photosynthetic efficiency of the leaves and xylem vessels structure under stress. Recently, Peter and Pinter (2015) reported that, the yield, clusters weight and the berries size of Blaufrankish grape variety increased by using of bio-stimulators containing amino acids but did not affect the fruit chemicals quality characters.

Calcium is the one of essential eliminates for stabilizing and intensification cell wall and membrane construction, including function of cell walls and membranes. Moreover, calcium applications to saline-sodic soils have a twin effect: 1) it enhances structure, aeration and drainage of the soil. 2) It supports the capacity of the roots to restrict sodium uptake through improving the Ca: Na ratio (Shao *et al.,* 2008). In this way, (Zhu-mei *et al.,* 2007) indicated that spraying of Ca on nurslings of Pinot Noir grape under moisture stress condition, increased soluble sugars content, catalase, and peroxidase enzymes activity, moreover it alleviates chlorophyll decomposition. Also, calcium plays an important role in enhancing fruit quality as cleared by several researchers (Kluter *et al.,* 2006, and Raese & Drake, 2008) they reported that, preharvest Ca spray treatments used to increase Ca content of the fruit cell wall were effective in delaying senescence, resulting in firmer fruits. Also, Marzouk and Kassem (2011) concluded that, spraying calcium chloride on Thompson seedless grapevines was effective in increased berries firmness and decreased the percentage of unmarketable clusters after storage at ambient temperature for seven days. However, Abd-Elghany (2006) noted that, spraying “Ruby seedless” grapevines with $CaCl_2$ (3g/L) three weeks after fruit set improved berry firmness and TSS.

Therefore, the present study was conducted to explain the effect of irrigation time at three levels of field capacity and foliar spray with silicon, calcium and amino acids which might help mitigate the possible adverse effect of deficit water, improving yield and fruit quality of “Thompson seedless" grapevines.

MATERIALS AND METHODS

A field experiment was conducted during two successive seasons 2016 and 2017 on ten years old, "Thompson seedless" grapevines (*Vitis vinifera* L.) grown in a private vineyard located at El Mehalla El Koubra, Gharbiya Governorate, Egypt. Vines were spaced at 1.5 meters in a row and 3 meters between rows under flow irrigation system. Cane pruning system adopted during winter pruning with modified Y ship supporting system. The buds load/vine was adjusted to 84 eyes (7 fruiting canes × 10 eyes plus 7 renewal spurs × two eyes). Vines were subjected to cultural practices which usually done in this area. The soil properties were measured according to Jackson (1973) and Klute (1986), where soil texture was clay (58% clay, 27% silt and 15% sand), soil pH 7.8, EC 2.1 dSm^{-1}. The chosen vines were vigor, uniform and healthy as possible and arranged in split plot design as follows:

The main plots were assigned for three irrigation levels as:

$I_{1=}$ irrigation at 30% depletion of soil available water.
$I_{2=}$ irrigation at 50% depletion of soil available water.
$I_{3=}$ irrigation at 70% depletion of soil available water.

The sub plots were ranged for four foliar sprays as:

$S_{1=}$ foliar sprays with tap water.
$S_{2=}$ foliar sprays with potassium silicate (SiO_2 25% + K_2O 10%) at 1.5 ml/l.
$S_{3=}$ foliar sprays with Calcium nitrate (CaO 26% + $NO_3$15.5%) at 1.0 g/l.
$S_{4=}$ foliar sprays with amino acids at 2ml/l (commercial product containing: total amino acids 20% + magnesium 8% + sulfur 10.6%).

The combinations between the two factors resulting twelve treatments (3 irrigation levels x 4 foliar applications) each treatment replicated three times with three vines in each replicate (3 replicate x 3 vines).

Irrigation treatments

Amount of irrigation water applied (WA) for each irrigation treatment was determined according to soil moisture content in soil samples taken from consecutive depth of 15 cm down to depth of 60 cm to reach its field capacity before conduct irrigation levels (at depletion of 30, 50 and 70% of AW) with 4569.6, 2881.8 and 2494.1m^3/fed/season distributed on 16, 9 and 7 irrigations, respectively as shown in Tables (1 and 2). Submerged orifice with fixed dimension was used to convey and measure the amount of water applied according to Michael (1978) as the following equation:

$$\mathbf{Q = CA\sqrt{2gh}}$$

Where: Q = Discharge through the orifice (L/sec.), C = Coefficient of discharge (0.61), A=Cross section area of the orifice, cm^2, g = Acceleration due to gravity, cm/sec^2 (981 cm/sec^2) and h = Pressure head, causing discharge through the orifice, cm.

Irrigation treatments were conducted after one week from fruit set. However, the first spray of foliar treatments was started when shoots reached 15-20 cm in length, and the second one was applied after fruit set and then were done continuously every two weeks till veraison stage (4sprays/ season).

Table (1): Some physical characteristics of soil and water constants for the studied vineyard at different soil depth (Average of the two growing seasons).

Soil depth (cm)	Soil water constants		
	Field Capacity (FC) %	**Permanent Wilting Point %**	**Available Water %**
0 – 15	47.34	22.24	25.10
15 – 30	43.83	20.34	23.49
30 – 45	40.45	19.88	20.57
45 – 60	37.77	18.50	20.27

Table: (2): The amount of irrigation water applied (m^3/fed.) for different irrigation levels during each growing season.

Irrigation Treatments	**Irrigations No.**	**Amount of each irrigation water m^3/ fed.**	**Water applied (WA) m^3/fed./season**
30% depleted Water	16	285.6	4569.6
50% depleted Water	9	320.2	2881.8
70% depleted Water	7	356.3	2494.1

For achieving the study purpose, the following data were recorded:

1. ***Yield and fruit physical parameters***
   - Cluster number/vine, cluster weight (g), and cluster length (cm) were recorded. The yield of each vine was determined as kg/vine then, total yield ton/feddan calculated as follows:
     Yield / feddan ton = (vine yield (kg) x number of vines per faddan) ÷ 1000.
   - Cluster compactness coefficient was determined in nine clusters per treatment by dividing the number of berries per cluster by cluster length.
   - Berry cracking and wrinkled % were estimated according to Becker and Knoche (2012) and expressed as a percent of bunch weight.
   - Berries length and diameter (mm) were determined in ten berries per cluster using digital vernal clipper.
   - Weight of 100 berries (g) was measured using digital balance.
   - Volume of 100 berries (ml) was determined by the water displacement method.
   - Berry firmness and berry removal force were measured in ten berries per cluster using the hand dynamometer apparatus model FDP1000 with a thump 1mm. The two parameters data were transformed into Newton

units according to El-Abbasy *et al.* (2015) using the transformed factor (1gram-force = 0.00980665 Newton).

- Berry shattering (%) was determined by berries weight percent of the cluster after given a two-light shakes by hand.
- Berries decay (%) was expressed as the decayed berries weight as percent per cluster weight.

2. *Fruit chemical parameters:*

- Berries juice soluble solids content (SSC%) was estimated using the hand refractometer apparatus
- The titratable acidity (%) was determined as mg of tartaric acid equivalent using Na OH (0.1N) in 100 ml of berries juice (A.O.A.C., 1990).
- SSC/ acid ratio was calculated using data of SSC % and that of titratable acidity.
- Productivity of irrigation water (PIW) calculated according to Ali *et al*. (2007) as follows:

  PIW = yield per feddan (kg) ÷ total irrigation water per feddan (m^3).

Statistical analysis

The experimental design was a split plot and all the collected data were statistically analyzed by the analysis of variance as described by Snedecor and Cochran (1990). The differences among treatments mean were compared using the least significant different LSD test.

RESULTS AND DISCUSSION

1. ***Yield and clusters quality:***

From data established in Table (3) it could be observed that, "Thompson seedless" vines irrigate at levels 30 and 50% depletion of soil available water (I_1 and I_2) produced the highest significant yield and cluster weight without significant difference between them in both seasons. On the contrary, the vines irrigated at 70% depletion of soil available water (I_3) gave the least values of the above-mentioned parameters in both seasons. Cluster length showed the same trend, where the vines irrigated with I_1 level gave the longest cluster in the first season, but by the second one, there are no significant differences between vines of I_1 and I_2 treatments. in other words, yield as ton/ feddan and its components was gradually increased with increasing water applied from 2494.1 to 4569.6 m^3 feddan/ year, but the differences in yield and cluster weight and cluster length

Table (3): Effect of water irrigation levels and silicon, calcium and amino acids foliar applications on yield and cluster physical quality parameters of "Thompson seedless" grapevine during 2016 and 2017 seasons

Treatments		Yield/ feddan (ton)		Cluster weight (g)		Cluster length (cm)		Compactness Coefficient	
		2016	2017	2016	2017	2016	2017	2016	2017
Irrigation main effect									
I_1		7.90	8.51	355.99	362.08	21.55	22.64	8.36	7.82
I_2		8.04	8.55	357.65	361.29	20.94	22.13	8.62	8.15
I_3		5.63	6.10	278.13	299.30	19.32	20.49	9.27	8.80
LSD at5%		0.718	0.664	3.491	2.540	0.607	0.718	0.493	0.470
Spray main effect									
S_1		6.74	7.23	318.76	320.71	19.72	20.70	9.22	8.72
S_2		7.05	7.68	329.35	340.88	20.35	21.59	8.81	8.35
S_3		7.12	7.73	327.60	343.57	20.44	21.72	8.73	8.30
S_4		7.83	8.22	346.64	358.40	21.89	23.00	8.25	7.84
LSD at 5%		0.226	0.211	2.765	2.587	1.715	1.853	0.313	0.262
Interaction									
	S_1	7.31	8.16	340.06	353.40	20.57	21.90	8.75	8.22
	S_2	7.78	8.43	358.03	355.04	21.90	22.13	8.22	8.13
I_1	S_3	7.86	8.47	351.73	359.40	21.10	22.83	8.53	7.88
	S_4	8.65	8.96	374.13	380.47	22.63	23.68	7.95	7.60
	S_1	7.76	8.08	345.92	345.12	19.87	20.93	9.06	8.60
	S_2	7.93	8.57	358.82	362.16	20.13	22.27	8.94	8.08
I_2	S_3	7.85	8.52	354.12	361.12	21.03	21.63	8.56	8.32
	S_4	8.60	9.02	371.75	376.75	22.73	23.70	7.92	7.59
	S_1	5.15	5.46	270.30	263.60	18.73	19.27	9.85	9.34
	S_2	5.45	6.05	271.21	305.44	19.03	20.37	9.26	8.84
I_3	S_3	5.66	6.61	276.96	310.20	19.20	20.70	9.11	8.70
	S_4	6.25	6.68	294.04	317.97	20.30	21.63	8.87	8.32
LSD at 5%		0.543	0.485	4.747	6.222	0.619	0.748	1.627	1.534

I_1, I_2 and I_3 = Irrigation at 30 (Control), 50 and 70% depletion of available water, respectively.

S_1, S_2, S_3 and S_4 = Foliar application with water (control), Silicon, Calcium and Amino acids, respectively.

produced by vines irrigated with 2881.8 and 4569.6 m^3 of water were not significant which indicate that, irrigation at 2881.8 m^3/feddan can be used without any destroys effects on yield and its components. However, vines of I_3 irrigation level showed the highest values of cluster compactness coefficient and the lowest values were noticed with the I_1 level during both seasons of the study.

These results were supported by those of Ojeda *et al.* (2001), Keller *et al.* (2008) and Diego and Castel (2010) on different grapevine cultivars. Porro *et al.* (2010) mentioned that, reducing irrigation levels on grapes by up to 60% would not have any impact on yield, but that the timing of the irrigation might be important for maintenance of yields. Also, Romero *et al.* (2015) reported that, the moderately-water-stressed "Tempranillo" grapevines showed greater yield than that severed water deficit irrigation.

Concerning the main effect of foliar applications, data of Table (3) cleared that, all foliar spray treatments (S_1, S_2, S_3 and S_4) enhanced yield and cluster physical parameters especially amino acids (S_4) sprays which gave significantly higher yield/ feddan, cluster weight, and cluster length per vine. In contrast control vines showed the lowest values of these characters and higher values of cluster compactness coefficient during both seasons of this study. Here it can point out that, vines of control (S_1) which produced the lowest cluster length and the highest cluster compactness coefficient. In this respect, Peter and Pinter (2015) reported that, amino acids sprays increased vine yield.

Regarding the interaction, data in Table (3) indicated that, "Thompson seedless" vines irrigated with I_1 and I_2 levels combined with amino acids foliar spray (S_4) showed a significant increase in yield/ feddan, cluster weight and cluster length without significant differences between them in both seasons. However, the lower values were obtained in vines exposed as more stress (I_3) irrigation level with all spray treatments for all the above characters. Moreover; the same level (I_3) of irrigation combined with tap water spray (control) showed the lowest cluster weight and cluster length values in both seasons of this study.

As for cluster compactness coefficient, vines treated with I_2 and I_3 in combined with amino acids showed the lower values however, the highest coefficient was noticed I_3 unsprayed (control) treatment. Similar results were obtained by Coruzzi and Last (2000), Romero *et al.* (2015) and Chaves *et al.* (2007) they concluded that, it can decrease the amount of water applied by 50% of available soil water without negative effects on yield and even get some gains of berries quality of two grapevine varieties Moscate and Castela.

2. Berries physical quality parameters

Data of Table (4) showed that, "Thompson seedless" vines irrigated at I_1 level had a significant increase in weight and volume of 100 berries as compared to other irrigation levels. Moreover, berry diameter and berry length showed a significant increase in vines under $I_1$and I_2 levels without significant differences between them during both seasons. On the other

Table (4). Effect of water irrigation levels and silicon, calcium and amino acids foliar applications on berries physical quality parameters of Thompson seedless grapevines during 2016 and 2017 seasons

Treatments		Weight of 100 Berries (g)		Vol. of 100 Berries (ml)		Berry length (mm)		Berry diameters (mm)	
		2016	2017	2016	2017	2016	2017	2016	2017
Irrigation main effect									
I_1		370.44	370.58	345.27	348.17	19.11	20.32	18.50	18.70
I_2		364.43	365.98	335.20	337.75	19.04	20.13	18.59	18.74
I_3		310.10	314.08	280.68	283.72	18.43	19.38	17.49	17.40
LSD at 5%		3.861	3.972	4.232	3.881	0.283	0.265	0.284	0.544
Spray main effect									
S_1		343.62	339.42	304.85	307.96	17.24	19.15	16.94	17.45
S_2		348.14	349.86	323.90	327.28	19.23	19.88	17.80	18.31
S_3		347.85	351.73	313.92	317.46	19.03	20.01	18.61	18.23
S_4		353.67	359.84	338.84	340.14	19.92	20.71	19.42	19.12
LSD at 5%		4.372	4.593	4.894	4.481	1.202	1.382	1.191	1.553
Interaction									
I_1	**S_1**	365.13	359.50	330.09	332.26	17.25	19.18	17.03	17.63
	S_2	371.10	368.17	347.47	350.03	19.70	20.33	18.13	18.67
	S_3	370.93	371.43	343.33	348.15	19.39	20.46	18.93	17.73
	S_4	374.60	383.20	360.19	362.23	20.09	21.29	19.89	19.77
I_2	**S_1**	360.17	358.53	317.32	321.18	17.30	19.16	17.11	17.71
	S_2	362.53	365.23	336.39	340.22	19.26	19.95	18.14	18.84
	S_3	361.83	364.87	324.58	329.12	19.14	20.15	19.25	18.79
	S_4	373.17	375.30	362.49	360.46	20.14	21.24	19.84	19.61
I_3	**S_1**	305.57	300.23	267.15	270.45	17.16	19.12	16.67	17.0
	S_2	311.50	316.17	287.85	291.58	18.44	19.36	17.12	17.42
	S_3	310.80	318.90	273.85	275.11	18.56	19.41	17.64	17.18
	S_4	313.23	321.03	293.85	297.74	19.54	19.61	18.52	17.99
LSD at 5%		7.572	7.942	8.473	7.761	1.784	2.002	1.953	2.212

I_1, I_2 and I_3 = Irrigation at 30 (control), 50 and 70% depletion of available water, respectively.
S_1, S_2, S_3 and S_4 = Foliar application with water (control), Silicon, Calcium and Amino acids, respectively.

hand, lower values of the above-mentioned berry physical parameters were noticed in vines irrigated at I_3 during both seasons of the study. These results are in harmony with that of Romero *et al.* (2015) and Shahidian *et al.* (2016) they summarized that, reducing irrigation by 70% from standard level (4 l/h) with 2-weeks irrigation stress period had a negative effect on berry weight, length and diameter.

Data of the same Table (4) cleared that, all foliar spray treatments were effective in enhancing berry quality as compared to control. Foliar spray with amino acids was more effective in this respect, where it showed the highest significant values of berry physical quality characters in terms of 100 berries weight, volume, berry diameter and length as compared with other treatments during both seasons of the study. However, the lowest values of all these characters were noticed with vines of control (sprayed with tap water) during both study seasons. These results were in harmony with that of Abd El-Monem *et al.* (2008).

Regarding the interaction, data of Table (4) mentioned that, all combinations among irrigation levels and foliar spray treatments cleared a positive effect on different berries quality as compared to the control of both studied factors. The combination between I_1 as well as I_2 irrigation levels with amino acids sprays recorded the highest significant increase in weight and volume of 100 berries, berry length and diameter in both seasons of this study. However, lower values of 100 berries weight, volume, berry length and diameters were noticed with vines treated by the combination of I_3+S_1. This trend was true during the two study seasons. Similar results were found by Mahajan and Tuteja (2005) and Peter & Pinter (2015).

Data illustrated in Table (5) showed that, decayed berries% had a positive trend with increasing irrigation water levels, where vines irrigated at 30% (I_1) depletion of available water showed the higher percent followed by that irrigated at 50 % (I_2), however, the lowest percentage was noticed with vines irrigated at 70% depletion of available water (I_3), this results were noticed during both seasons. The decreasing in berry decay as a result of decreasing water irrigation can be explained according to the fact that, reducing of irrigation play an important role in limiting vegetative growth of vines that enhancing light penetration and reduced the relative humidity in vine microclimate which such condition is unacceptable for fangs development as cleared by Ramteke *et al.* (2017). In contrast, berry cracking and berry wrinkled percentages showed a positive trend with decreasing irrigation levels from 4569.6 to 2494.1 m^3 feddan/year, where these characters reached a significant increase in vines irrigated with I_3 followed by that irrigated with I_2 levels, however, the lowest percentage was noticed with control (I_1) vines, this trend was true during both study seasons.

Berry cracking is serious problems in grapes, where it is a physiological disorder of fruit surface leads to most important commercial

Table: (5) Effect of water irrigation levels and silicon, calcium and amino acids foliar applications on decayed berries, berry cracking and berry wrinkled of "Thompson seedless" grapevines during 2016 and 2017 seasons

Treatments		Berries decay %		Berry cracking %		Berry wrinkled %	
		2016	2017	2016	2017	2016	2017
Irrigation main effect							
	I_1	1.37	1.80	1.99	1.73	1.05	1.13
	I_2	1.25	1.67	4.60	4.78	2.13	3.73
	I_3	1.08	1.16	10.60	9.55	5.67	7.31
LSD at 5%		**0.271**	**0.127**	**2.011**	**1.819**	**0.858**	**0.940**
Spray main effect							
	S_1	1.74	2.10	10.60	11.27	5.92	9.35
	S_2	1.14	1.52	3.05	2.17	1.20	1.40
	S_3	0.80	1.06	2.20	1.87	0.77	0.87
	S_4	1.25	1.49	7.07	6.10	3.90	4.61
LSD at 5%		**0.571**	**0.822**	**1.853**	**1.744**	**0.886**	**0.921**
Interaction							
I_1	**S_1**	1.85	2.62	5.30	4.50	3.10	2.40
	S_2	1.17	1.67	0.00	0.00	0.00	0.00
	S_3	0.92	1.27	0.00	0.00	0.00	0.00
	S_4	1.55	1.62	2.65	2.40	1.10	2.12
I_2	**S_1**	1.75	2.05	10.60	12.30	4.30	8.22
	S_2	1.16	1.71	1.20	1.20	1.01	1.30
	S_3	0.93	1.25	1.30	1.40	1.00	1.20
	S_4	1.14	1.68	5.30	4.20	2.20	4.20
I_3	**S_1**	1.62	1.63	15.90	17.00	10.37	17.42
	S_2	1.10	1.19	7.95	5.30	2.60	2.90
	S_3	0.55	0.65	5.30	4.20	1.30	1.40
	S_4	1.06	1.17	13.25	11.70	8.40	7.50
LSD at 5%		**0.240**	**0.280**	**1.213**	**1.098**	**1.015**	**1.295**

I_1, I_2 and I_3 = Irrigation at 30 (control), 50 and 70% depletion of available water, respectively.
S_1, S_2, S_3 and S_4 = Foliar application with water (control), Silicon, Calcium and Amino acids, respectively.

losses in grape production through reducing both yield and quality (Ramteke *et al.*, 2017). Also berry wrinkled is a phenomenon that leads to berry appearance is unacceptable for marketing. There are many factors affecting these phenomena as the deficit of water irrigation especially after veraison Bondada and Keller (2012).

As for foliar spray treatments, data of the same Table recorded that, all foliar spray applications were effective in reducing berry disorders (decayed, cracking and wrinkled) as compared to control. Calcium sprays (S_3) were very effective in this respect followed by silicon spray (S_2) however; the higher percentages of these parameters were cleared with control (spray with tap water) in the two study seasons. These results are in agreement with that of Ramteke *et al.* (2017) they concluded that, Calcium plays an important role in strengthening and stabilizing the cell wall and membrane structure which reducing these disorders.

Regarding the interaction, data of Table (5) cleared that, generally all spray treatments (S_2, S_3 and S_4) significantly reduced the decayed berries, berry cracking and berry wrinkled percentages under all irrigation levels (I_1, I_2 and I_3), especially calcium sprays when combined with I_3 irrigation level which produced the lowest decayed berries in both seasons of the study. However, calcium (S_2), as well as, silicon (S_3) sprays in combined with irrigation at 30% depletion of available water (I_1) were very effective, since it did not show any percent of berry cracking and wrinkled, on contrary, vines irrigated at 70% depletion of available water (I_3) combined with control (water spray) showed the highest percentages of berry cracking and wrinkled. This trend was true in both seasons of the study. These results are in harmony with that of Yamamoto *et al.* (1990) and Ramteke *et al.* (2017) concluded that, there are several strategies can be used for the prevention of these disorders as monitoring water management, soil moisture and spraying of some micronutrient and Abd El-Rhman (2010) who reported that, fluctuation in soil moisture regimes and vine nutritional status can affect berry cracking and berry wrinkled. Moreover, Bhavya *et al.* (2011) reported that, foliar silicon supply on grapes showed great benefits as enhancing resistance against disease and drought. The positive effect of calcium and silicon on reducing decayed berries could be explained as the known role of calcium on cell wall, since Ca is involved in maintaining cell wall integrity by binding carboxyl groups of polygalacturonate chains, which are present in the middle lamella and primary cell wall, also binding of Si with cell-wall hemicelluloses which improved structural stability of fruits (Apaolaza, 2014).

Data of Table (6) illustrated that, irrigation at 30 and 50% depletion from soil available water (I_1 and I_2) cleared higher values of berry firmness and berry removal force without significant differences between them, however, irrigation at 70% depletion of available water (I_3) showed the lowest values of these characters in both seasons of this study. In contrast, the same treatments (I_1 and I_2) showed the lowest percentage of shattered berries with no significant differences between them however, the highest value was achieved by vines irrigated with the I_3 level in both seasons.

Table (6). Effect of water irrigation levels and silicon, calcium and amino acids foliar applications on berry firmness, berry removal force and shattered berries of "Thompson seedless" grapevines during 2016 and 2017 seasons

Treatments		Berry firmness (Newton)		Berry removal force (Newton)		Berries Shatter %	
		2016	**2017**	**2016**	**2017**	**2016**	**2017**
Irrigation main effect							
I_1		3.36	4.58	**4.41**	4.89	1.27	1.02
I_2		3.32	4.68	**4.47**	4.91	1.31	1.04
I_3		2.80	3.51	**3.36**	4.58	2.00	1.53
LSD at 5%		**0.470**	**0.529**	**0.549**	**0.257**	**0.332**	**0.485**
Spray main effect							
S_1		2.89	3.81	3.88	4.34	1.78	1.67
S_2		3.28	4.54	4.23	5.10	1.40	0.94
S_3		3.49	4.64	4.22	5.16	1.31	0.74
S_4		2.99	4.02	3.98	4.59	1.61	1.43
LSD at 5%		**0.261**	**0.252**	**0.302**	**0.272**	**0.543**	**0.703**
Interaction							
I_1	**S_1**	3.11	4.01	4.17	4.57	1.55	1.52
	S_2	3.55	4.96	4.51	5.08	1.14	0.87
	S_3	3.64	5.03	4.57	5.06	1.02	0.50
	S_4	3.14	4.33	4.37	4.85	1.37	1.19
I_2	**S_1**	3.15	4.30	4.22	4.44	1.66	1.64
	S_2	3.44	4.89	4.68	5.21	1.21	0.72
	S_3	3.57	4.87	4.62	5.25	1.08	0.53
	S_4	3.12	4.66	4.35	4.75	1.28	1.25
I_3	**S_1**	2.41	3.13	3.26	4.00	2.14	1.85
	S_2	2.84	3.78	3.49	5.01	1.86	1.22
	S_3	3.25	4.03	3.46	5.16	1.82	1.20
	S_4	2.71	3.08	3.21	4.16	2.19	1.85
LSD at 5%		**0.452**	**0.591**	**0.343**	**1.023**	**1.434**	**0.382**

I_1, I_2 and I_3 = Irrigation at 30 (control), 50 and 70% depletion of available water, respectively.
S_1, S_2, S_3 and S_4 = Foliar application with water (control), Silicon, Calcium and Amino acids, respectively.

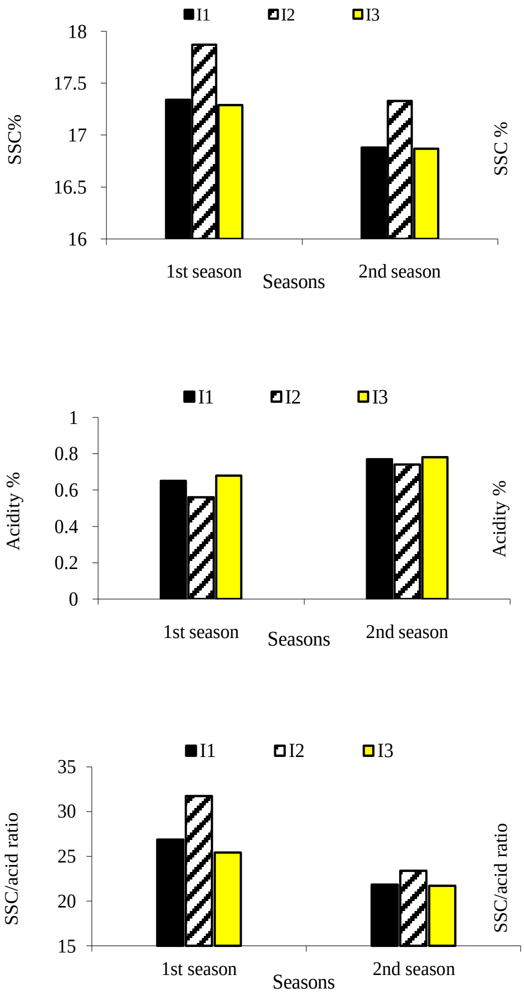
The same results were found by Chaves *et al.* (2007) concluded that, we can decrease the amount of water applied by 50% of available soil water without negative effects on different berries quality of Moscate and Castela grapevine varieties.

Foliar spray applications on the same Table (6) showed that, calcium (S_2) and silicon (S_3) foliar sprays had a positive effect in enhancing berry firmness, berry removal force with higher significant values and lower values of shattered berries, but unsprayed treatment (S1) recorded the highest values of shattered berries in both seasons of the study. These results are in agreement with that of several researchers they cleared beneficial effect of calcium Bonomelli and Rafael (2010), silicon Meena *et al.* (2014) and amino acids Khosroshahi *et al.* (2007) foliar sprays on grape berries firmness under different abiotic (salinity, drought and deficit water) stresses.

Regarding the interaction, it could be noticed that, vines under all irrigation treatments in combined with calcium foliar spray (S_3) gave significantly higher berry firmness during the two seasons. The lower value of this character was noticed with vines treated with I_3 combined with S_1 in both seasons. However, vines irrigated with I_2 in combined with S_2 followed by S_3 cleared higher values of berry removal force, on contrary the lower values were noticed in vines irrigated with I_3 combined with unsprayed (S_1) as well as amino acids spray (S_4) without significant differences between them in both seasons. On the other hand, the higher percentages of shattered berries were noticed with I_3 irrigation level combined with unsprayed (S_1) and amino acids (S_4) treatments. However, the lower values were observed with vines sprayed with calcium (S_3) under all irrigation levels in both seasons. Our similar results are found by Amiri *et al.* (2009) concluded that, Calcium foliar spray reduced shattered berries of "Thompson seedless". Also, Ramteke *et al.* (2017) concluded that, calcium nutrient increased cell wall thickness and decreased the formation of the abscission layer that leads to reducing shattering.

3. Berries chemical quality parameters

As shown in Figure (1) it could be noticed that, berries SSC% increased with reducing irrigation water to 50% depletion of available water (I_2) as compared with both control (I_1) and irrigation at 70% depletion of available water (I_3) in the two seasons of the study. By the second season, there are no differences between I_1 and I_3. In contrary, the titratable acidity of berry juice was reached the lowest percentages in vines irrigated with I_2 in both seasons. SSC/acid ratio showed the same trend of SSC% in both seasons, where the highest ratio was found with irrigation at I_2 level. These results are in agreement with those findings of Khosroshahi *et al.* (2007) and Keller *et al.* (2008) reported that, deficit irrigation levels enhanced SSC% of Cabernet Sauvignon berries under arid climate conditions. Also, Opazo *et al.* (2010) concluded that, moderate and severe water stress significant increased soluble solids grapevines cv. Cabernet Sauvignon. Moreover,



Figure(1): Effect of irrigation levels on berries SSC%, acidity and SSC/acid ratio of "Thompson seedless" grape during 2016 and 2017 seasons

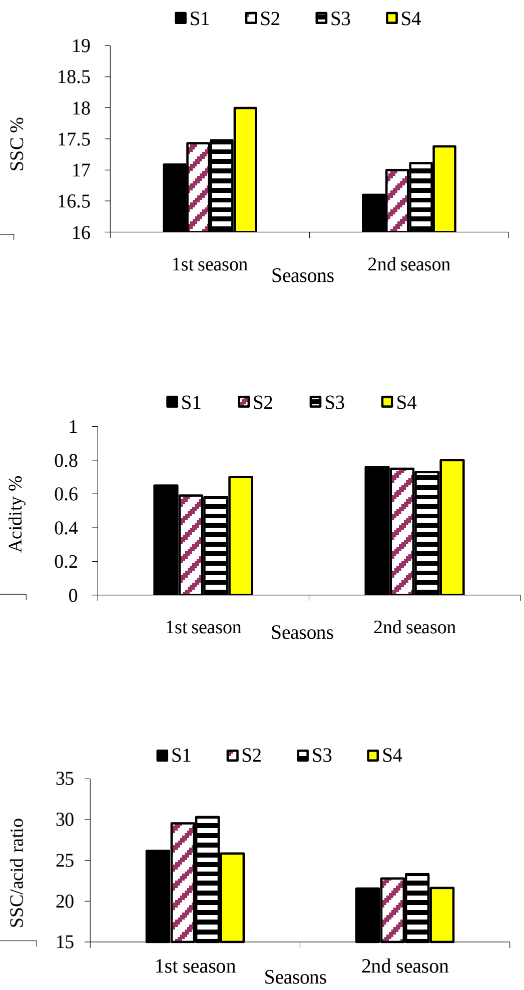


Figure (2): Effect of foliar sprays on berries SSC%, acidity and SSC/acid ratio of "Thompson seedless" grape during 2016 and 2017 seasons

I_1, I_2 and I_3 = Irrigation at 30 (control), 50 and 70% depletion of available water, respectively.

S_1, S_2, S_3 and S_4 = Foliar spray with water (control), Silicon, Calcium and Amino acids, respectively.

El-Sayed (2013) summarized that, deficit irrigation enhanced carbohydrate reserve to cluster and enhanced SSC versus acidity.

Regarding foliar spray treatments at Figure (2) it cleared that, berries SSC% of vines that sprayed with amino acids (S_4) had the highest values as compared to the other treatments (S_1, S_2 and S_3) during the two seasons of study. From the same figure, the highest berry acidity percent was obtained with amino acids spray followed by the control in both seasons. On the other hand, the highest SSC/acid ratio was found with foliar spray with S_3 followed by S_2 in the two study seasons. Similar findings were recorded by Ojeda *et al.* (2001) and Romero *et al.* (2015) and Khan *et al.* (2012) summarized that, multiple foliar applications of amino acids increased titratable acidity ratio (29%) and pH of juice (3%) of grape cv. 'Perlette'.

Data of Interaction between irrigation and foliar spray treatments in Table (7) indicated that, vines irrigated by 50% depletion of soil available water combined spraying with amino acids vines (I_2+ S_4) gave the highest significant SSC% as compared with other treatments in both seasons. However, unsprayed treatment combined with both I_1 and I_3 showed the lower percent of SSC, this trend was true during the two seasons.

Berry juice acidity was affected by different foliar spray treatments, where vines irrigated with I_2 combined with both S_3 and S_2 showed the lower percentages of acidity. However, vines irrigated control (I_1) combined with amino acids (S_4) sprays as well as that irrigated at I_3 combined with S_4 showed the higher berry acidity in the two seasons, respectively. By the second one, foliar application with S_3 as well as S_1 under irrigation levels of I_1 and I_2 showed the lower percent with no significant differences among all of them however, the higher values were obtained with the combination between I_1 and S_4. Data of berry juice SSC/acid ratio showed that, foliar spray with S_3 and S_2 on vines under I_2 irrigation level showed the higher ratio in the first season, that trend was found with S_1 and S_3 in the second season. However, the lowest value was obtained with vines of I_3 which sprayed with water (control) in both seasons. These results are in harmony with those obtained by El-Ansari *et al.* (2005) on table grapes cv. 'Muscat of Alexandria' under different irrigation regimes and Al-Obeed (2011) on "Flame seedless" grape sprayed with pre-harvest calcium chloride and amino acids.

4. Productivity of water irrigation (PIW)

The productivity of water irrigation is considered as an evaluation parameter of yield per Kg/m^3 of irrigation water applied. Data of PIW illustrated in Table (8) cleared that, Thompson seedless vines irrigated at I_2 and

Table (7): Interaction effect of water irrigation levels and silicon, calcium and amino acids foliar applications on berry SSC%, titratable acidity and SSC/ acid ratio of "Thompson seedless" grape during 2016 and 2017 seasons

Treatments		SSC %		Titratable acidity %		SSC/Acid ratio	
		2016	2017	2016	2017	2016	2017
I_1	S_1	16.80	16.23	0.65	0.79	25.85	20.54
	S_2	17.35	17.07	0.61	0.74	28.44	23.07
	S_3	17.40	16.93	0.58	0.72	30.00	23.51
	S_4	17.80	17.27	0.74	0.84	24.05	20.56
I_2	S_1	17.67	17.33	0.60	0.73	29.45	23.74
	S_2	17.73	17.20	0.53	0.75	33.45	22.93
	S_3	17.67	17.20	0.50	0.73	35.34	23.56
	S_4	18.40	17.57	0.62	0.75	29.68	23.43
I_3	S_1	16.80	16.23	0.71	0.79	23.66	20.54
	S_2	17.20	16.73	0.63	0.75	27.30	22.31
	S_3	17.37	17.20	0.65	0.75	26.72	22.93
	S_4	17.80	17.30	0.73	0.82	24.38	21.10
LSD at 5%		**1.211**	**1.012**	**0.153**	**0.094**	**2.712**	**2.242**

I_1, I_2 and I_3 = Irrigation at 30 (control), 50 and 70% depletion of available water, respectively.
S_1, S_2, S_3 and S_4 = Foliar application with water (control), Silicon, Calcium and Amino acids, respectively.

I_3 levels showed the higher values of PIW without significant differences between them in both seasons. This shows the possibility of using the second level (I_2) without any effect on yield with the less irrigation water applied compared with I_1. These results are reinforced by the results of Romero *et al.* (2015) they concluded that, it can decrease the amount of water applied by 50% without negative effects on yield of two grapevines Moscate and Castela varieties.

Data of the same Table (8) cleared that, foliar spray applications enhanced the use of irrigation water, where all sprayed substances (S_2, S_3 and S_4) showed the highest values as compared to control, especially amino acids (S_4) in both seasons. Interaction effect data in Table (8) cleared that, all spray treatments (S_2, S_3 and S_4) combined with second and third irrigation levels (I_2 and I_3) showed the best results for productivity of irrigation water without significant difference among all of them in both seasons.

Table (8): Effect of water irrigation levels and silicon, calcium and amino acids foliar applications on productivity of irrigation water (PIW) during 2016 and 2017 seasons

Treatments		Productivity of water irrigation (PIW) 2016	2017
Irrigation main effect			
I_1		1.73	1.86
I_2		2.79	2.97
I_3		2.26	2.45
LSD at 5%		0.242	0.271
Spray main effect			
S_1		2.12	2.26
S_2		2.21	2.41
S_3		2.24	2.43
S_4		2.46	2.59
LSD at 5%		0.031	0.044
Interaction			
I_1	S_1	1.60	1.79
	S_2	1.70	1.84
	S_3	1.72	1.85
	S_4	1.89	1.96
I_2	S_1	2.69	2.80
	S_2	2.75	2.97
	S_3	2.72	2.96
	S_4	2.98	3.13
I_3	S_1	2.06	2.19
	S_2	2.19	2.43
	S_3	2.27	2.49
	S_4	2.51	2.68
LSD at 5%		0.664	0.686

I_1, I_2 and I_3 = Irrigation at 30 (control), 50 and 70% depletion of available water, respectively.

S_1, S_2, S_3 and S_4 = Foliar application with water (control), Silicon, Calcium and Amino acids, respectively.

CONCLUSION

According to the investigated results we can be concluded that, the moderate deficit irrigation water (50% depletion of soil available water) could be adopted in "Thompson seedless" vineyards under the study conditions without any major defect on productivity, clusters and berries characters, especially when it combined with amino acids foliar spray when shoots recorded 15-20 cm in length, after fruit set and continues every two weeks till veraison stage witch enhanced different clusters and berries physical and chemical quality characters. Moreover, it raised greatly the productivity of irrigation water which can be applied on irrigation systems under arid and semi-arid climate.

REFERENCES

A.O.A.C. (1990). *Association of Official Agriculture Chemists.* Official methods of analysis, 15th Ed. Washington. D.C., USA.

Abd El-Monem, E.A.A.; M.M.S. Saleh, and E.A.M. Mostafa (2008). Minimizing the quantity of mineral N fertilizers on grapevine by using humic acid, organic and biofertilizers. *Res. J. Agric. Bio. Sci.,* 4 (1): 46-50.

Abd El-Rhman, I. E. (2010). Physiological studies on cracking phenomena of Pomegranates. *J. Appl. Sci. Res.* 6: 696-703.

Abd-Elghany, A.A. (2006). Effect of lime and calcium on growth and fruit quality of Ruby seedless grapevines. *J. Agric. Sci. Mansura*, Univ., 31(9):6221-6227.

Ali, M.H.; M.R. Hoque, A.A. Hassan and A. Khair (2007). Effects of deficit irrigation on yield, water productivity, and economic returns of wheat. *Agricultural Water Management*, 92(3): 151-161.

Al-Obeed, R.S. (2011). Enhancing the shelf life and storage ability of "Flame seedless"grapevine by agrochemicals preharvest foliar applications. *Middle-East Journal of Scientific Research,* 8(2): 319-327.

Amiri, E. **M.; E. Fallahi and G. Safari (2009).** Effects of Preharvest Calcium Sprays on Yield, Quality and Mineral Nutrient Concentrations of 'Asgari' Table Grape. *International Journal of Fruit Science*, 9 (3):294-304

Apaolaza, L. H. (2014). Can silicon partially alleviate micronutrient deficiency in plants? a review. *Planta.* 240(3):447-58

Becker, T. and M. Knoche (2012). Deposition, strain, and microcracking of the cuticle in developing 'Riesling' grape berries. *Vitis,* 51: 1–6.

Belal, B.E.A.; M.A. El-Kenawy and M.K. Uwakiem (2016). Foliar Application of Some Amino Acids and Vitamins to Improve Growth, Physical and Chemical Properties of Flame Seedless Grapevines. *Egypt. J. Hort*., 43(1):123-136.

Bhavya, H. K.; V.N. gowda, S. Jaganath, K.N. Sreenivas and N.B. Prakash (2011). Effect of foliar silicic acid and boron acid in Bangalore blue grapes. *Proceedings of The 5th International Conference on Silicon in* Agriculture. September 13-18, 2011 Beijing, China

Bondada, B. and M. Keller (2012). Morphoanatomical Symptomatology and Osmotic Behavior of Grape Berry Shrivel. *J. Amer. Soc. Hort. Sci*. 137(1):20-30.

Bonomelli, C. and R. Rafael (2010). Effects of foliar and soil calcium application on yield and quality of table grape cv. 'Thompson seedless'. *Journal of Plant Nutrition* , 33(3): 299-314

Chaves, M.M.; T.P. Santos, C.R. Souza, M.F. Ortun, M.L. Rodriguez and J.P. Maroco (2007). Deficit irrigation in grapevine improves water-use efficiency while controlling vigour and production quality. *Ann Appl. Biol.* 150: 237–252

Coruzzi, G. and R. Last (2000). *Amino acids. In Biochemistry and Molecular Biology of Plants*. B. Buchanan W. Gruissem R. Jones (eds.). Amer. Soc. Plant Biol., Rockville, MD, USA., 358-410.

Davies, D.D. (1982). *Physiological Aspects Of Protein Turn Over*. Encycl. Plant Physiol. New Series, HA (Nucleic acids and proteins: Structure biochemistry and physiology of proteins). Ed. Boulter D, Partheir B. Spring Verlag. Berlin, Heidelberg and New York., 90-288.

Diego, S.I. and J.R. Castel (2010). Response of grapevine cv. 'Tempranillo' to timing and amount of irrigation: water relations, vine growth, yield and berry and wine composition. *Irrig. Sci.*, 28:113-125

El-Abbasy, U. K.; S. M. Al-Morsi, F. E. Ibrahim and M. H. Abd El-Aziez (2015). Effect of Gibberellic Acid, Cytofex and Calcium Chloride as Pre-Harvest Applications on Storability of "Thompson Seedless" Grapes. *Egypt. J. Hort*., 42(1): 427- 440.

El-Ansari, D.O.; O. Oakayama, K. Hirano and G. Okamoto (2005). Response of Muscat of Alexandria table grapes to post-veraison regulated deficit irrigation in Japan. *Vitis* , 44 (1):5–9

El-Sayed, M.E.A. (2013). Improving Fruit Quality and Marketing of "Crimson Seedless" Grape Using Some Preharvest Treatments. Journal of Horticultural Science & Ornamental Plants 5 (3):218-226.

Habibi, G. (2015). Effects of soil- and foliar-applied silicon on the resistance of grapevine plants to freezing stress. *Acta Biologica Szegediensis*, 59(2):109-117

Hattori, T.I.S.; H. Araki, S. Mortia, M. Luxova and A. Lux (2005). Application of silicon enhanced drought tolerance in Sorghum bicolor. *Physio Plantarum*, 123:459-466.

Jackson M.L. (1973). *Soil Chemical Analysis Prentice Hall of India Private*, LTD, New Delhi.

Jia, J.X.; D.L. Cai and Z.M. Liu (2011). New progress in silicon-improvement of quality of crops. *Proceedings of The 5th International Conference on Silicon in Agriculture September* 13-18, 2011 Beijing, China, pp77.

Keller, M.; R.P. Smithyman and L.J. Mills (2008). Interactive Effects of Deficit Irrigation and Crop Loadon Cabernet Sauvignon in an Arid Climate. *Am. J. Enol. Vitic*. 59(3):221-234.

Khan, A.S.; B. Ahmad, M.J. Jaskani, R. Ahmad and A.U. Malik (2012). Foliar application of mixture of amino acids and seaweed (*Ascophylum nodosum*) extract improve growth and physico-chemical properties of grapes. *International Journal of Agriculture and Biology*., 14: 383-388

Khosroshahi, M.R. Z.; M. Esna-Ashari and A. Ershadi (2007). Effect of exogenous putrescine on postharvest life of strawberry (*Fragaria ananassa* Duch.) fruit, cultivar Selva. *Scientia Horticulturae* 114:27-32.

Klute, A. (1986). Water Retention: Laboratory Methods. In: A. Koute (ed.), Methods of soil Analysis, *Part 1.2nd ed. Agron. Monogr. 9, ASA, Madison, W1 U.S.A.*, pp. 635-660.

Kluter, R.A.; D.T. Nattress, C.P. Dunne and R.D. Popper (2006). Shelf life Evaluation of Bartlett Pears in Retort Pouches. *Journal of Food Science,* 6: 1297-1302.

Mahajan, S. and N. Tuteja (2005). Cold, salinity and drought stresses: *Archives of Biochemistry and Biophysics An overview*, 444:139-158.

Martínez-de-Toda, F. and P. Balda (2013). Delaying berry ripening through manipulating leaf area to fruit ratio. *Vitis* , 52 (4):171-176.

Marzouk, H.A. and H.A. Kassem (2011). Improving yield, quality, and shelf life of Thompson seedless grapevine by preharvest foliar applications. *Postharvest Biology and Technology*, 130(2):425-430.

Meena, V.D.; M.L. Dotaniya , V.S. Coumar and A.S. Rao (2014). A Case for Silicon Fertilization to Improve Crop Yields in Tropical Soils. *Proc. Natl. Acad. Sci., India, Sect. Biol. Sci*. 84(3):505-518

Meunier, M.; S. Rogiers, G. Gurr and R. Siret (2011). Grapevine vegetative growth and reproductive development in response to silicon supplementation. *Proceedings of The 5th International Conference on Silicon in Agriculture September* 13-18, pp126.

Michael, A.M. (1978). *Irrigation Theory And Particle*. Vikas Publishing House PVTLTD New Delhi Bombay.

Ojeda, H.A.; A. Deloire and A. Carbonneau (2001). Influence of water deficits on grape berry growth. *Vitis* , 40:141-145

Opazo, C.A.; S.O. Farias and S. Fuentes (2010). Effects of grapevine (Vitis vinifera L.) water status on water consumption, vegetative growth and grape quality: An irrigation scheduling application to achieve regulated deficit irrigation. *Agricultural Water Management*, 97:956-964.

Peter, T.N. and T. Pinter (2015). Effects of Foliar Biofertilizer Sprays on Nutrient Uptake, Yield, and Quality Parameters of Blaufrankish (*Vitis vinifera* L.) Grapes. Journal Communications in Soil Science and Plant Analysis, *Special Issue on the 13th International Symposium on Soil and Plant Analysis,* 46: 219-227.

Porro, D.; M. Ramponi, T. Tomasi, L. Rolle and S. Poni (2010). Nutritional implications of water stress in grapevine and modifications of mechanical properties of berries. ISHS Acta Horticulturae 868: *VI International Symposium on Mineral Nutrition of Fruit Crops*.

Pradeep, M.M. and S. Elamathi (2007). Effect of foliar application of DAP, micronutrients and NAA on growth and yield of green gram (*Vigna radiata* L.). Legume Res., 30(4):305-307.

Raese, J.T. and S.R. Drake (2008). Effects of preharvest calcium sprays on apple and pear quality. *Journal of Plant Nutrition*, 16(9):1807-1819.

Ramteke, S.D.; V. Urkude, S.D. Parhe and S.R. Bhagwat (2017). Berry Cracking; Its Causes and Remedies in Grapes - A Review. *Trends in Biosciences* , 10(2):549-556.

Romero, P.; R.G. Munoz, J.I. Fernández-Fernández, F.M. Amor and J. García-García (2015). Improvement of yield and grape and wine composition in field-grown Monastrell grapevines by partial rootzone irrigation, in comparison with regulated deficit irrigation. *Agric. Water Manage.* 149:55-73.

Shahidian, S.; P. Valverde, R. Coelho and A. Santos (2016). Leaf water potential and sap flow as indicators of water stress in Crimson 'seedless' grapevines under different irrigation strategies. *Theor. Exp. Plant Physiol*., 28:221-239.

Shao, H. B.; W.Y. Song and L.Y. Chu (2008). Advances of calcium signals involved in plant anti-drought. *C R Biol* ., 331:587-596.

Silva, C.C.; G.S. Selles-von, R.E. Ferreyra and H.R. Silva (2012). Variation of water potential and trunk diameter answer as sensitivity to the water availability in table grapes. *Chil J Agric Res*., 72(4):459-469.

Snedecor, G. W. and W. G. Cochran (1990). *Statistical Methods*. 7th Ed. The Iowa State Univ. Press, Ames. Iowa, USA, p. 393.

Upadhyaya, H.; S.K. Panda and B.K. Dutta (2011). CaCl2 improves post drought recovery potential in Camellia sinensis (L) O Kuntze. *Plant Cell Rep.*, 30:495-503.

Yamamoto, T.: M. Kudo and S. Watanabe (1990). Fruit cracking and characteristics of fruit thickening in 'Satonishiki' cherry. *J. Japanese Soc. Hort. Sci.*, 59 (2): 325-332.

Zhu-mei, x. I.; F. Yu-lin, G. Yu-zhi and Z. Zhen-wen (2007). The effect of water stress on main physiological indexes of wine grape leaf. Agricultural Research in the Arid Areas, *www.cnki.com.cn* 2007-03.

تأثير مستويات الرى مع الرش الورقى بالسيليكون والكالسيوم والاحماض الامينية على العنب البناتى
أ: المحصول وجودة ثمار

صا بر سعد بسيونى[1] -على السيد سيد احمد زغلول[2] -مها حسيب عبد العزيز[2]
١ - قسم بحوث العنب - معهد بحوث البساتين - مركز البحوث الزراعية - الجيزة - مصر
٢ - قسم بحوث تداول الفاكهة- معهد بحوث البساتين - مركز البحوث الزراعية - الجيزة – مصر

أجريت هذه الدراسة خلال موسمى ٢٠١٦ و ٢٠١٧ وذلك لاختبار مستويات مختلفة من الرى وهى عند استنفاذ ٣٠ ، ٥٠ ، ٧٠% من الماء المتاح بالتربة بالاضافة الى معاملات الرش وهى المقارنة (الكنترول) والرش بسليكات البوتاسيوم (اكسيد سيليكون ٦٥% + اكسيد بوتاسيوم ٣١%) و نيترات الكالسيوم (اكسيد كالسيوم ٢٦% + نيتروجين ٥١.٥%) والاحماض الامينية (منتج تجارى يحتوى ٢٠% احماض امينية +٨ %مغنسيوم + ١٠.٦% كبريت) بمعدلات ١.٥ ، ١ حم/لتر ، ٢ مل/لتر على التوالى وتأثير ذلك على المحصول وصفات الجودة لثماركرمات العنب البناتى النامية فى التربة الطينية والمزروعة على ابعاد غرس ١.٥ و٣ متر بين الكرمات و الصفوف على التوالى وتروى بنظام الرى بالغمر بمنطقة المحلة الكبرى بمحافظة الغربية. تم تطبيق معاملات الرى بعد العقد فى حين نفذت معاملات الرش عند وصول طول النموات الى ١٥-٢٠ سم وبعد العقد واستمرت كل اسبوعين حتى مرحلة طراوة الثمار.

- اوضحت النتائج تأثر كل من المحصول وصفات جودة العناقيد والحبات للعنب البناتى بمستويات الرى المستخدمة، حيث اظهرت معاملات رى الكرمات عند

استنفاذ ٣٠ او ٥٠ % من الماء المتاح بالتربة زيادة معنوية فى المحصول وجودة الثمار وذلك مقارنة بالرى عند استنفاذ ٧٠% من الماء المتاح.

- كما أظهرت نتائج معاملات الرش بالمركبات المذكورة تحسنا معنويا فى مختلف صفات الجودة للعناقيد والحبات وكانت معاملة الرش بالاحماض الامينية الاكثر تأثيرا فى مختلف قياسات الجودة للعناقيد (الوزن و الطول) والحبات (القطر والطول ووزن وحجم ال ١٠٠ حبة) مقارنة بمعاملة المقارنة .
- عكست النتائج المتحصل عليها من التداخل بين كل من معاملات الرى والرش المذكورة ان الكرمات التى تم ريها عند استنفاذ ٣٠ او ٥٠% من الماء المتاح بالتربة مع الرش بالاحماض الامينية أظهرت تحسنا معنويا فى المحصول وصفات الجودة للعناقيد والحبات مقارنة بباقى المعاملات ، كما اظهرت الكرمات التى تم ريها عند المستويين السابقين مع الرش بالكالسيوم والسيليكون زيادة معنوية فى كل من صلابة الحبات والقوة اللازمة لنزعها من العنقود وانخفاض فى نسبة انفراط (الفرطة) الحبات وكذا نسبة الاعفان بالعنقود .
- معدلات الرى المتوسط (عند استنفاذ ٥٠% من الماء المتاح بالتربة) زادت من نسبة المواد الصلبة الذائبة الكلية ونسبة المواد الصلبة الذائبة الكلية/ الحموضة وخفضت نسبة الحموضة فى عصير الثمار.
- تحسنت كفاءة الاستهلاك المائى للكرمات التى رويت عند استنفاذ ٥٠% من الماء المتاح بالتربة دون الخفض فى المحصول مع الاحتفاظ بجودة ثمار العنب البناتى.

التوصية: يمكن خفض كمية المياة المستخدمة فى رى العنب البناتى تحت ظروف التجربة بحوالى ٥٠% دون حدوث انخفاض فى المحصول مع الاحتفاظ بجودة العناقيد و الحبات.