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EFFECT OF POTASSIUM SILICATE SPRAY WITH PACKAGING ON STORABILITY AND CONTROL POSTHARVEST DISEASES OF GRAPE VINE FRUITS

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ABSTRACT: ***The experiment was carried out during the two successive seasons (2016 and 2017) on two new grape varieties ARRA 15 and ARRA 18 cultivated in sandy soil at Sadat city, Menoufia governorate, Egypt to study the effect of sprayed potassium silicate as preharvest with modified air packaging (MAP) on; postharvest quality, storage and marketing abilities, and control of postharvest diseases of grape fruits. Results showed that potassium silicate or modified air packaging separately or joined has leads to improvement the maintenance of all quality, storage and marketing abilities, and control of postharvest diseases of grape fruits during the total storage period (5 weeks) when compared to non-treated fruits, which showed loss of all studied properties after only 3 weeks of storage under cold storage. Out of the present study (results), it could be recommended to apply both; spraying with potassium silicate along with modified air packaging to maintenance grape quality storage and marketing abilities, and reducing of postharvest diseases.***

Key words: ***potassium silicate- packaging- varieties "ARRA 18" and "ARRA 15"- cold storage - gray mould***

INTRODUCTION

Grapes (*Vitis vinifera, L.*) ranks as the second major fruit crop in Egypt following Citrus. Vineyards have increased in the last years especially in the newly reclaimed lands (Abd El-Migeed, *et al* 2006). New introduced grapevines cultivars ARRA 18 and ARRA 15. ARRA 18 is earliest color (black) seedless a while ARRA 15 White table grapes is early - season grape variety in Egypt with a firm, crispy texture and sweet, neutral taste and have the ability of exporting and marketing.

Many attempts have been carried out to find the best horticultural practices should be applied to improve yield and berry quality of the prime, popular and shelf life is important only in grapes intended for table use. Decreasing quality during postharvest handling of table grapes is often associated with water loss and decay. Browning of the cluster stem and shelling of berries is another problem. Grapes are considered as one of the promising exported crops in Egypt. The exported quantity of the Egyptian grapes is still 1.4% of the total grapes production through the period of 2001-2006 (El-Sawalhy, 2008). Generally, using of both Modified Atmosphere Packaging (MAP) and potassium silicate improves drought resistance and increase the shelf life of fruits, (Dibb, 1998). (Rizk-Alla and Meshrake, 2006) reported that, preharvest application of potassium green on fruit ”Crimson seedless” resulted in the highest berry shattering percentage, fruit quality and storability. As well as potassium foliar application enhanced berry firmness (Nofal and Rezk 2009). (Rizk-Alla and Meshrake, 2006) worked on “Crimson seedless” table grape and found that sparing with

potassium lead to an increase of color, total soluble solids; Also, TSS% gradually increased till the end of the storage period. Decreases in juice titratable acidity percentages with the enhancement of potassium levels were due to interacts with tartaric acid at form of potassium tartarate which has limited solubility.

Increased O_2 demand of processed product dictates that packaging films with regulation of internal O_2 and CO_2 concentrations is essential issue to maintain the fresh state. MAP was developed to regulate CO_2 and O_2 concentrations by using plastic liners with different gas perm abilities in conjunction with fruit respiration at a given temperature, (Kader, 2002) and (Sabir, *et al.* 2010) found that MAP slows down the respiration of commodity, such combined effect would enhance the storage period of grapes by efficiently delaying reduction of fresh weight, SSC, pH, berry decay. Recently dipping in solutions of natural compounds in combination with MAP was proven as promising means for postharvest control decay; (Valero *et al.*, 2006 and Ergun *et al.*, 2008). During storage and transport stages of table grape, *Botrytis cinerea* is the most harmful phytopathogenic fungi causing the gray mould decay, being the main phytopathological problem that must face on the export industry of fresh grape, (Williamson *et al.* 2007).

Many studies have used silicate salts as a safe alternative to pesticides to control fungal plant diseases. Exogenous application of silicon (Si) in the form of sodium meta silicate reduced disease development caused by *Penicillium expansum* and *Monilinia fructicola* in sweet cherry fruit; (Qin and Tian, 2005). Postharvest application of silicon oxide and sodium silicate suppressed postharvest pink rot severity caused by *Trichothecium roseum*in on muskmelons, (Guo, *et al.* 2007).

The present study aimed to study the effect of used both potassium silicate and MAP treatments individual or combination on grey mould and maintaining the qualities and storability during storage at $0^{O}C$ of new grape cultivars ARRA 18 and ARRA 15 in Egypt.

MATERIALS AND METHODS

The present study was carried out during the seasons 2016 and 2017 in a private farm at El Sadat area, El-Menoufia Governorate, Egypt. Three-years old of cultivars "ARRA 18 and ARRA 15" new table grape variety, grape vines were used as a plant material for this study. Grape vines devoted for this work were healthy, carefully selected as being representative of the chosen cultivars and as uniform as possible in vigor and shape. All selected vines from two cultivars were grown in sandy soil; planted at 1.5×3 meters a part, ARRA 18 and ARRA 15 Baron-h modified system, and received regularly the same horticultural care adopted in this orchard. Drip irrigation system was applied. Eighteen vines were selected from each cultivar as a completely randomized design and divided into two groups. Each group was replicated three times and each replicate was represented by three vines.

Potassium silicate

Spraying was applied on the vegetative growth and clusters by potassium silicate (K_2O 10%+SiO_2 25%) rate 6 cm^3/L (equal 5L/Fed[1]) at one group and by tap water (control) with the second group. Just after berry setting (Mid of April), three weeks later (1^{st} week of May) and three weeks later (1^{st} week of June).

Modified atmosphere packaging

Packed by modified atmosphere packaging (MAP) type Extend® films Easy-Tear bags (StePac Ltd.)

Fungal decay

B. cinerea were isolated from naturally infected table grapes berries from storage at Giza governorate and maintained on potato dextrose agar. The purified isolate was identified according to their morphological features using the descriptions of Jarvis, 1977. Fungal culture was identified in Postharvest disease Dept., Plant Pathology Institute, ARC, Giza Governorate, Egypt. Pure cultures were maintained at 4°C in PDA tubes. Spores were harvested from 7 days-old PDA fungal cultures grown at 25±1°C, by adding 3 through two layers of cheesecloth, and the concentration was adjusted to -4 ml of 2% (w/v in water) of Tween 80 in each Petri dish. Suspensions were filtered 10^4 spores / ml.

This experiment included the following four treatments:

1- Control (tap water and unpackaging) T_1
2- Tap water + Modified atmosphere packaging type (MAP) T_2
3- Potassium silicate (K_2O10%+SiO_2 25%) rate 6 cm^3/ L (equal 5 L / Fed[1]) T_3
4- Potassium silicate (K_2O10%+SiO_2 25%) rate 6 cm^3/ L (equal 5 L / Fed[1]) + Modified atmosphere packaging type (MAP) T_4

All the collected samples (144 clusters) from each treatments (treated with potassium silicate and tap water) were divided into two groups, each group has either 72 packed and 72 unpacked, and then, each group had been divided into sub-group each one has either 36 artificially inoculated with spore and 36 uninfected clusters. Three replicates were used for such treatment. Each replicates containing 12 clusters.

The clusters from each replicates were placed in carton box (2 boxes for each replicate). One of those boxes was for determining the losses of fresh weight % and the other one was for determining the changes in the physical and chemical properties during the storage. The physical and chemical analysis were conducted at the Plant Pathology Research Institute, where the samples were stored for five weeks at 0^0C and 90 – 95% relative humidity.

Clusters quality parameters of all treatments were analyzed weekly as follows:

- Physical characteristics:

1- Losses of Fresh weight % (FWL %):-
Fresh weight losses percentage was calculated as percentage throughout the experimental periods.

2- Berries Firmness was determined by using Flfra texture analyzer equipment by penetrating cylinder 2 mm diameter to a constant distance with a constant speed 2mm/second. The results were expressed as a resistance force of the skin or flesh (Ib $inch^{-2}$).

3- Decay % :-
The disease incidence percentages of infected berries were recorded as follows:

Disease incidence% = $$\frac{\text{Number of diseased berries}}{\text{Total number berries of the treatment}} \text{X} 100$$

Efficiency%= $$\frac{\text{disease incidince of the control treatment - disease incidance of the treatment}}{\text{disease incidance of the control treatment}} \text{X} 100$$

- Chemical characteristics:

Freshly prepared of the berry juice samples were used for total soluble solids (TSS), total acidity as tartaric acid (TA) and total sugars (TS) determinations as described by (A. O. A. C. 2003).

Anthocyainin:

The anthocyainin was determined by using the spectrophotometer at wave length of 535 mm, according to the methods of (Husain, *et al.* 1965).

Changes in sugars and phenols content in infected Table Grapes after 35 days of storage time. Determinations of phenolic compounds were calorimetrically determined as described by (Snell and Snell 1953).

Statistical Analysis Procedure:

Data of the two seasons were analyzed statistically by the analysis of variance using one way ANOVA according to (Snedecor and Cochran, 1990) using SAS package. Comparison of treatment means was done using Tukey test at significance level 0.05.

RESULTS AND DISCUSSION

Losses of Fresh weight % (FWL%):

The effect of different treatments on weight loss changes of ARRA15 & ARRA18 berries during the storage are presented in Tables 1 (a & b) and 2 (a & b). The rate of weight loss increased with the storage time at 0ºC.

MAP with or without potassium silicate treatments significantly, retarded the loss in weight and the weight loss 4% values of these treatments were lower than at ARRA15 & ARRA18 respectively. Such delay in weight loss may be attributed to the effect of MAP on decreasing the respiration rate of fruits (Kader, 2002) and on restriction of malate dehydrogenises (MDH) activity (Ke, *et al*. 1995), one of the most active enzymes involved in certain metabolic pathways that result in senescence of fruit tissues. From such physiological perspective, the essential role of low O_2 and high CO_2 levels of MAP appears to be related solely with its restrictive impact on the activities of enzymes responsible for respiration. MAP is also proven as a good water vapor barrier and is able to maintain a relative humidity inside the pack (Philips, 1996). This attribute helped to retard the moisture content of stem less berries. On the other hand, there was high significant difference between control (7.99 & 9.24) and potassium silicate treatment (5.65 & 7.71) at ARRA15 and ARRA18 respectively regarding weight loss, indicating the effectiveness of potassium silicate on restraining the moisture inside the berry. Evaporation of intercellular water during the storage is the main factor responsible for direct loss in weight, (Wills, *et al.* 1998) and ultimate quality of grapes, (Sabir *et al.* 2010), clear that MAP enhance the storage period of grapes by efficiently delaying reduction of fresh weight.

Berries Firmness (Ib inch^{-2}).

As shown in Tables 3 & 4 data revealed that, berry firmness decline towards the end of storage period (5 weeks). At the end of storage period, the highest firmness value (1.83, 2.0 Ib inch^{-2} at ARRA15 and 1.37, 1.87 Ib inch^{-2} at ARRA18) were obtained by potassium silicate plus MAP, flowed by potassium silicate (0.9, 1.43 Ib inch^{-2} at ARRA15 & 0.93, 1.17 Ib inch^{-2} at ARRA18), MAP without potassium (0.97, 1.33 Ib inch^{-2} at ARRA15 and 0.83, 1.03 Ib inch^{-2} at ARRA18) and control (0.6, 0.83 Ib inch^{-2} at ARRA15 and 0.43, 0.53 Ib inch^{-2} at ARRA18), in both seasons, respectively. In contrast, potassium silicate foliar application enhanced berry firmness. These results are in agreement with those obtained on grape berries by (Abdel-Mohsen, 2007) on "Crimson seedless " and (Nofal and Rezk, 2009)

reported that potassium foliar application enhanced berry firmness on table grapes. On the other hand, MAP packaging application delayed loss berry firmness. These results are in agreement with those obtained on grape berries by (Sabir, *et al* 2010) that MAP slows down the respiration of commodity, such combined effect would enhance the storage period of grapes on "Muskule" table grapes.

Table (1) a : Effect of pre-and postharvest treatments on fresh weight loss percentage (%) of (ARRA15 & ARRA18) table grape berries stored at 0°C during 2016 season.

Weight Loss%								
First season								
Times		0	1	2	3	4	5	Mean
(A) ARRA 15	T_1	0.00 a	1.78 b	2.89 bc	4.92 a	7.14 a	7.99 ab	4.12 AB
	T_2	0.00 a	0.00 c	0.00 d	0.00 c	1.72 de	3.30 cd	0.84 D
	T_3	0.00 a	1.11 bc	1.61 cd	2.71 b	4.48 bc	5.65 bc	2.59 C
	T_4	0.00 a	0.00 c	0.00 d	0.00 c	0.00 e	1.73 d	0.29 D
(B) ARRA 18	T_1	0.00 a	3.69 a	5.17 a	5.93 a	7.11 a	9.24 a	5.19 A
	T_2	0.00 a	0.00 c	0.00 d	0.00 c	2.71 cd	3.97 cd	1.11 D
	T_3	0.00 a	1.36 b	3.65 ab	5.48 a	5.94 ab	7.71 ab	4.02 D
	T_4	0.00 a	0.00 c	0.00 d	0.00 c	0.30 e	1.74 d	0.34 D
Mean (A)		0.00 A	0.72 B	1.13 B	1.91 B	3.33 B	4.67 B	1.96 B
Mean (B)		0.00 A	1.26 A	2.20 A	2.85 A	4.01 A	5.67 A	2.67 A

Means in same column by similar letters are not statistically different at 0.05 level according to Tukey test.
T_1 - Control **T_3 - potassium silicate**
T_2 - MAP (Modified atmosphere packaging) **T_4 - potassium silicate + MAP**

Table (1) b: Effect of pre-and postharvest treatments on fresh weight loss percentage (%) of (ARRA15 & ARRA18) table grape berries stored at 0°C during 2016 season.

Weight Loss% infection								
First season								
Times		0	1	2	3	4	5	Mean
(A) ARRA 15	T_1	0.00 a	2.07 b	3.66 bc	6.36 b	8.00 b	9.37 ab	4.91 B
	T_2	0.00 a	0.00 c	0.00 d	0.00 d	2.32 cd	3.90 cd	1.04 C
	T_3	0.00 a	1.64 b	2.54 c	4.47 c	6.20 b	7.97 b	3.80 B
	T_4	0.00 a	0.00 c	0.00 d	0.00 d	1.60 cd	2.30 d	0.65 C
(B) ARRA 18	T_1	0.00 a	3.83 a	5.53 a	9.26 a	10.38 a	10.73 a	6.62 A
	T_2	0.00 a	0.00 c	0.00 d	0.00 d	2.95 c	4.50 c	1.24 C
	T_3	0.00 a	2.10 b	4.79 ab	5.88 b	6.50 b	9.44 ab	4.79 B
	T_4	0.00 a	0.00 c	0.00 d	0.00 d	0.67 d	2.64 cd	0.55 C
Mean (A)		0.00 A	0.93 B	1.55 B	2.71 B	4.53 B	5.89 B	2.60 B
Mean (B)		0.00 A	1.48 A	2.58 A	3.79 A	5.12 A	6.83 A	3.30 A

Means in same column by similar letters are not statistically different at 0.05 level according to Tukey test.
T_1 - Control **T_3 - potassium silicate**
T_2 - MAP (Modified atmosphere packaging) **T_4 - potassium silicate + MAP**

Table (2) a : Effect of pre-and postharvest treatments on fresh weight loss percentage (%) of (ARRA15 &ARRA18) table grape berries stored at 0°C during 2017 season.

Weight Loss%								
Second season								
Times		0	1	2	3	4	5	Mean
(A) ARRA 15	T_1	0.00 a	1.59 a	3.09 ab	4.72 a	6.05 b	6.82 b	3.71 B
	T_2	0.00 a	0.00 b	0.00 d	0.00 c	1.43 d	2.30 d	0.62 D
	T_3	0.00 a	0.97 a	1.95 c	2.90 b	3.65 c	4.94 c	2.40 C
	T_4	0.00 a	0.00 b	0.00 d	0.00 c	0.00 e	1.10 d	0.18 D
(B) ARRA 18	T_1	0.00 a	1.76 a	3.52 ab	5.79 a	7.55 a	8.62 a	4.54 A
	T_2	0.00 a	0.00 b	0.00 d	0.00 c	0.93 de	2.37 d	0.55 D
	T_3	0.00 a	1.24 a	2.63 bc	4.81 a	6.50 ab	7.47 ab	3.77 B
	T_4	0.00 a	0.00 b	0.00 d	0.00 c	0.00 e	1.13 d	0.19 D
Mean (A)		0.00 A	0.64 A	1.26 B	1.90 B	2.78 B	3.79 B	1.73 B
Mean (B)		0.00 A	0.75 A	1.54 A	2.65 A	3.75 A	4.90 A	2.26 A

Means in same column by similar letters are not statistically different at 0.05 level according to Tukey test.

T_1 - Control
T_2 - MAP (Modified atmosphere packaging)
T_3 - potassium silicate
T_4 - potassium silicate + MAP

Table (2) b: Effect of pre-and postharvest treatments on fresh weight loss percentage (%) of (ARRA15 &ARRA18) table grape berries stored at 0°C during 2017 season.

Weight Loss% infection								
Second season								
Times		0	1	2	3	4	5	Mean
(A) ARRA 15	T_1	0.00 a	2.07 ab	3.66 ab	6.36 a	7.87 a	8.63 a	4.77 AB
	T_2	0.00 a	0.00 c	0.00 c	0.00 d	2.74 c	3.43 c	1.03 D
	T_3	0.00 a	1.63 b	2.43 b	3.87 c	5.23 b	6.97 b	3.36 C
	T_4	0.00 a	0.00 c	0.00 c	0.00 d	1.03 de	1.63 d	0.44 D
(B) ARRA 18	T_1	0.00 a	2.49 a	4.18 a	6.23 a	7.74 a	9.47 a	5.02 A
	T_2	0.00 a	0.00 c	0.00 c	0.00 d	1.85 cd	3.14 c	0.83 D
	T_3	0.00 a	1.79 ab	3.08 ab	5.32 b	7.12 a	8.73 a	4.34 B
	T_4	0.00 a	0.00 c	0.00 c	0.00 d	0.00 e	2.90 c	0.48 D
Mean (A)		0.00 A	0.93 A	1.52 A	2.56 B	4.22 A	5.17 B	2.40 B
Mean (B)		0.00 A	1.07 A	1.81 A	2.89 A	4.18 A	6.06 A	2.67 A

Means in same column by similar letters are not statistically different at 0.05 level according to Tukey test.

T_1 - Control
T_2 - MAP (Modified atmosphere packaging)
T_3 - potassium silicate
T_4 - potassium silicate + MAP

Table (3): Effect of pre-and postharvest treatments on Firmness (lbs /Inch^2) of (ARRA15 & ARRA18) table grape berries stored at 0^{o}C during 2016 season.

Firmness								
First season								
Times		0	1	2	3	4	5	Mean
(A) ARRA 15	T_1	3.77 a	3.23 a	2.60 b	2.27 cd	0.90 de	0.60 de	2.23 C
	T_2	3.77 a	3.57 a	3.40 a	2.73 b	1.70 bc	0.97 c	2.69 B
	T_3	4.17 a	3.60 a	3.23 a	2.60 bc	1.93 b	0.90 c	2.74 B
	T_4	4.17 a	3.67 a	3.50 a	3.23 a	2.53 a	1.83 a	3.16 A
(B) ARRA 18	T_1	2.50 a	1.93 d	1.53 d	1.13 f	0.67 e	0.43 e	1.37 E
	T_2	2.50 a	2.17 cd	1.87 cd	1.60 e	1.10 d	0.83 cd	1.68 D
	T_3	3.00 a	2.50 bc	1.97 cd	1.73 e	1.17 d	0.93 c	1.88 D
	T_4	3.00 a	2.70 b	2.30 bc	2.10 d	1.60 c	1.37 b	2.18 C
Mean (A)		3.97 A	3.52 A	3.18 A	2.71 A	1.77 A	1.08 A	2.70 A
Mean (B)		2.75 A	2.33 B	1.92 B	1.64 B	1.13 B	0.89 B	1.78 B

Means in same column by similar letters are not statistically different at 0.05 level according to Tukey test.

T1 - Control **T3 - potassium silicate**

T 2 - MAP (Modified atmosphere packaging) **T4 - potassium silicate + MAP**

Table (4): Effect of pre-and postharvest treatments on Firmness (lbs /Inch^2) of (ARRA15 & ARRA18) table grape berries stored at 0^{o}C during 2017 season.

Firmness								
Second season								
Times		0	1	2	3	4	5	Mean
(A) ARRA 15	T_1	3.40 b	2.63 bc	2.27 cd	1.77 d	1.03 e	0.83 e	1.99 DE
	T_2	3.40 b	3.00 bc	2.73 c	2.23 c	1.90 c	1.33 bc	2.43 C
	T_3	4.77 a	3.93 a	3.30 b	3.00 b	2.63 b	1.43 b	3.18 B
	T_4	4.77 a	4.40 a	3.97 a	3.50 a	2.93 a	2.00 a	3.59 A
(B) ARRA 18	T_1	2.40 c	2.07 d	1.70 e	1.27 e	0.87 e	0.53 f	1.47 F
	T_2	2.40 c	2.37 cd	2.13 de	1.93 cd	1.53 d	1.03 de	1.90 E
	T_3	2.53 c	2.37 cd	2.13 de	1.83 cd	1.37 d	1.17 cd	1.90 E
	T_4	2.53 c	2.47 cd	2.43 bc	2.20 cd	2.03 c	1.87 a	2.26 CD
Mean (A)		4.08 A	3.49 A	3.07 A	2.63 A	2.13 A	1.40 A	2.80 A
Mean (B)		2.47 B	2.32 B	2.10 B	1.81 B	1.45 B	1.15 B	1.88 B

Means in same column by similar letters are not statistically different at 0.05 level according to Tukey test.

T1 - Control **T3 - potassium silicate**

T 2 - MAP (Modified atmosphere packaging) **T4 - potassium silicate + MAP**

Decay :-

Effect of pre-harvest sprays with potassium silicate in controlling the Post-harvest infection of grey mold of table grapes during cold storage, potassium silicate sprays on grape plants of ARRA 15 and ARRA 18 varieties reduced development of grey mold on unpacked post-harvesting table grape or in modified atmosphere consumer packaging (MAP) and stored at 0°C and 90- 95% RH for 35 days during seasons 2016 and 2017 (Table 5). Grape berries of control treatment (without pre-harvest potassium silicate spray) kept in MAP showed less decay development either in naturally infected or artificially inoculated grape berries with *B.cinerea* than when kept without packaging. ARRA 15 berries of control treatment kept in MAP or without packaging showed less decay on naturally infected or artificially inoculated than ARRA 18 berries was artificially inoculated with *B. cinerea*. This finding referred to higher susceptibility of ARRA 18 berries to fungal infection particularly *B. cinerea* than ARRA 15 berries. Disease incidence was higher on ARRA 18 berries artificially inoculated with *B. cinerea* than ARRA 15 berries. When the grape berries were kept in MAP, ARRA 15 berries showed less disease infection than ARRA 18 berries, ARRA 15 berries showed less decay than ARRA 18 berries during the both seasons' experiments.

Table (5): Effect of pr-harvest application with potassium silicate in controlling the post-harvest infection of gray mold of(ARRA15 & ARRA18) table grapes using packaging under cold storage at 0 CO and 90:95% RH for 35 days seasons 2016 & 2017.

Treatments		Disease incidence (%) (D.I)							
		First season				Second season			
		Botrytis cinerea		Natural infection		*Botrytis cinerea*		Natural infection	
		DI	Efficacy	DI	Efficacy	DI	Efficacy	DI	Efficacy
(A) ARRA 15	T_1	38.00 a		7.18 b		37.17 b		6.63 b	
	T_2	10.20 c	73.16	1.87 c	73.96	9.53 c	74.36	1.50 cd	77.38
	T_3	6.13 de	83.87	1.00 d	86.07	5.13 de	86.20	0.77 e	88.39
	T_4	3.43 f	90.97	0.00 e	100.00	2.93 e	92.12	0.00 f	100.00
(B) ARRA 18	T_1	42.67 a		9.40 a		44.00 a		8.70 a	
	T_2	10.37 c	75.69	2.17 c	77.00	6.63 d	84.93	1.90 c	78.16
	T_3	6.33 d	85.17	1.47 cd	84.36	5.60 d	87.27	1.10 de	87.35
	T_4	4.00 ef	90.62	0.00 e	100.00	3.00 e	93.18	0.00 f	100.00
Mean (A)		14.44 B	82.67	2.51 B	86.68	13.69 B	84.23	2.23 B	88.56
Mean (B)		15.84 A	83.83	3.26 A	87.09	14.81 A	88.46	2.93 A	88.52

Means in same column by similar letters are not statistically different at 0.05 level according to Tukey test.

T1 - Control T3 - potassium silicate

T 2 - MAP (Modified atmosphere packaging) T4 - potassium silicate + MAP

DI = Disease incidence EF = Efficacy

As for data of seasons 2016 and 2017 on ARRA 15 in Table 5 Pre harvest application with potassium silicate then kept unpacking or in MAP significantly reduced disease percentage of berries with *B. cinerea* comparing with the inoculated control berries (unpacked and without potassium silicate). In this respect, keeping grape berries in MAP enhanced the efficacy of pre-harvest sprays with potassium silicate to control gray mold. More suppressing of *B. cinerea* on kept grape berries in MAP was simultaneously obtained when grape vines were pre-sprayed with potassium silicate compared with other treatments. However, potassium silicate combined with MAP lowered gray mold on grape berries with efficacies 90.97, 92.12 at ARRA15 and 90.62, 93.18 at ARRA18 were inoculated during two seasons, respectively. As for naturally infected ARRA 15 and ARRA18 berries kept in MAP with potassium silicate completely suppressed the fungal decay during seasons 2016 and 2017, respectively.

Also, potassium silicate successfully suppressed the fungal decay on naturally infected fruits. (Yang *et al*., 2010) revealed synergistic effects of silicon on disease control in apple brown rot (*Monilinia fructicola*). Foliar application of Si was effective in controlling tomato fruit rot caused by *Phytophthora capsici* (Mersha, *et al*. 2012). In contrast, post-harvest Si application was found to be ineffective for controlling gray mould (*B. cinerea*) in strawberry (Lopes, *et al*. 2014). Also, (Ramírez and Palou 2016) found that potassium silicate dips significantly reduced the incidence of green mold by 45% with respect to control fruit ('Valencia' oranges).

Total soluble solids (TSS %):-

TSS% levels in all treatments progressively increased along with the prolonged storage, probably due to water loss and the slow ripening process occur in berries although the grape is a nonclimacteric fruit (Tables 6 & 7). After 5 weeks storage, effect of treatments on TSS change was found significant. All applications inhibited the increase in TSS, in varying degrees, as previously indicated (Sabir, *et al.* 2006, Sabir, *et al.* 2008).Non-treated berries presented a greater increase in TSS% level, reaching to peak value of 22.8 & 22.2 ºBrix at ARRA15 and 21.23 & 21.33 ºBrix at ARRA18 after three weeks, in both seasons respectively while combined effect of both MAP and potassium silicate treatments on delaying the TSS change was obvious, with the value of 23.73 & 24.07 on ARRA15 and 22.37 & 23.73 on ARRA18 after 5 weeks, in both seasons, respectively. On discussing the previous results, increasing juice TSS% with the enhancement of potassium levels could be due to the K promotion for the translocation of products of photosynthesis in plant, (Saleh, *et al.* 2007) on "Thompson seedless" grape vines. In this respect, mango fruits spray with potassium silicate at preharvest increased TSS% in mango fruits, (EL mehrat, *et al.* 2017).

Total acidity (TA %):

As shown in Table 8 and 9, the effects of treatments on TA% change during the storage were insignificant. However, TA% levels in overall berries apparently decreased during the storage. The gradual decrease in acid level during the storage may physiologically be attributed to increase in membrane permeability allowing acids stored in cell vacuoles to be respired and transformation of acids to sugars (Sabir *et al.* 2010) besides certain other processes occur inside the cells. Therefore, reduction in tartaric acid level might influence solely the activity of many enzymes involved in respiratory metabolism, preharvest spraying application treatment by potassium

Table (6): Effect of pre-and postharvest treatments on TSS% of (ARRA15 & ARRA18) table grape berries stored at 0oC during 2016 season.

TSS (%)								
First season								
Times		0	1	2	3	4	5	Mean
(A) ARRA 15	T_1	17.93 ab	20.90 a	22.07 ab	22.80 a	19.50 d	17.97 d	20.19 BC
	T_2	17.93 ab	19.27 bc	21.07 abc	21.47 a	21.73 b	22.70 ab	20.69 AB
	T_3	17.70 b	19.13 ab	22.37 a	22.57 a	22.70 a	23.23 ab	21.28 A
	T_4	17.70 b	18.03 c	18.80 e	21.20 ab	22.73 a	23.73 a	20.37 B
(B) ARRA 18	T_1	18.13 a	19.60 ab	20.73 bc	21.23 ab	18.20 e	16.80 d	19.12 D
	T_2	18.13 a	18.40 bc	18.97 de	19.50 bc	20.20 cd	21.17 c	19.39 D
	T_3	17.93 ab	18.80 bc	20.20 cd	21.43 a	21.67 b	22.13 bc	20.36 B
	T_4	17.93 ab	18.50 bc	18.83 de	19.17 c	20.60 c	22.37 b	19.57 CD
Mean (A)		17.82 B	19.33 A	21.08 A	22.01 A	21.67 A	21.91 A	20.63 A
Mean (B)		18.03 A	18.83 A	19.68 B	20.33 B	20.17 B	20.62 B	19.61 B

Means in same column by similar letters are not statistically different at 0.05 level according to Tukey test.

T1 - Control **T3 - potassium silicate**

T 2 - MAP (Modified atmosphere packaging) **T4 - potassium silicate + MAP**

Table (7): Effect of pre-and postharvest treatments on TSS% of (ARRA15 & ARRA18) table grape berries stored at 0oC during 2017 season.

TSS (%)								
Second season								
Times		0	1	2	3	4	5	Mean
(A) ARRA 15	T_1	18.40 a	19.23 a	20.97 a	22.20 ab	19.17 e	17.97 d	19.66 DE
	T_2	18.40 a	18.90 a	20.90 ab	21.80 ab	22.20 bc	22.87 b	20.84 AB
	T_3	18.20 a	19.43 a	20.50 abc	22.73 ab	23.00 ab	23.60 ab	21.24 A
	T_4	18.20 a	19.03 a	20.03 abc	23.07 a	23.37 a	24.07 a	21.29 A
(B) ARRA 18	T_1	18.10 a	19.33 a	19.73 abc	21.33 bc	18.90 e	17.77 d	19.19 E
	T_2	18.10 a	18.87 a	19.33 c	19.93 c	21.27 d	22.00 c	19.92 CD
	T_3	18.47 a	19.07 a	19.53 bc	20.17 c	22.20 bc	22.80 bc	20.37 BC
	T_4	18.47 a	18.90 a	19.33 c	19.83 c	21.33 cd	23.73 a	20.27 C
Mean (A)		18.30 A	19.15 A	20.60 A	22.45 A	21.93 A	22.13 A	20.76 A
Mean (B)		18.28 A	19.04 A	19.48 B	20.32 B	20.93 B	21.58 B	19.94 B

Means in same column by similar letters are not statistically different at 0.05 level according to Tukey test.

T1 - Control **T3 - potassium silicate**

T 2 - MAP (Modified atmosphere packaging) **T4 - potassium silicate + MAP**

Table (8): Effect of pre-and postharvest treatments on total acidity (TA %) of (ARRA15 & ARRA18) table grape berries stored at 0oC during 2016 season

Acidity (%)								
First season								
Times		0	1	2	3	4	5	Mean
(A) ARRA 15	T_1	1.050 a	0.900 a	0.769 a	0.619 bc	0.450 c	0.281 d	0.678 CD
	T_2	1.050 a	0.919 a	0.863 a	0.731 ab	0.656 ab	0.563 ab	0.797 A
	T_3	1.050 a	0.900 a	0.825 a	0.712 abc	0.638 ab	0.469 bc	0.766 ABC
	T_4	1.013 a	0.937 a	0.881 a	0.769 a	0.750 a	0.638 ab	0.831 A
(B) ARRA 18	T_1	1.103 a	0.788 a	0.694 a	0.581 c	0.450 c	0.300 d	0.653 D
	T_2	1.103 a	0.919 a	0.844 a	0.731 ab	0.638 ab	0.469 bc	0.784 AB
	T_3	1.087 a	0.844 a	0.731 a	0.619 bc	0.525 bc	0.394 cd	0.700 BCD
	T_4	1.087 a	0.937 a	0.844 a	0.712 abc	0.656 ab	0.544 ab	0.797 A
Mean (A)		1.041 A	0.914 A	0.835 A	0.708 A	0.624 A	0.488 A	0.768 A
Mean (B)		1.095 A	0.872 A	0.778 B	0.661 B	0.567 B	0.427 A	0.733 B

Means in same column by similar letters are not statistically different at 0.05 level according to Tukey test.

T1 - Control **T3 - potassium silicate**

T 2 - MAP (Modified atmosphere packaging) **T4 - potassium silicate + MAP**

Table (9): Effect of pre-and postharvest treatments on total acidity (TA %) of (ARRA15 & ARRA18) table grape berries stored at 0oC during 2017 season

Acidity (%)								
Second season								
Times		0	1	2	3	4	5	Mean
(A) ARRA 15	T_1	0.844 a	0.731 bc	0.656 b	0.600 ab	0.394 d	0.225 e	0.575 CD
	T_2	0.844 a	0.750 abc	0.713 ab	0.638 ab	0.525 c	0.300 de	0.628 BCD
	T_3	0.919 a	0.844 ab	0.731 ab	0.656 ab	0.638 ab	0.375 cd	0.694 AB
	T_4	0.919 a	0.881 a	0.807 a	0.731 a	0.675 ab	0.488 ab	0.750 A
(B) ARRA 18	T_1	0.825 a	0.675 c	0.619 b	0.563 b	0.370 d	0.276 de	0.555 D
	T_2	0.825 a	0.731 bc	0.694 ab	0.619 ab	0.600 abc	0.440 bc	0.652 BC
	T_3	0.844 a	0.712 bc	0.656 b	0.600 ab	0.563 bc	0.440 bc	0.636 BCD
	T_4	0.844 a	0.806 abc	0.750 ab	0.694 ab	0.656 ab	0.548 ab	0.716 AB
Mean (A)		0.881 A	0.802 A	0.727 A	0.656 A	0.558 A	0.347 B	0.662 A
Mean (B)		0.835 A	0.731 A	0.680 A	0.619 A	0.547 A	0.426 A	0.640 A

Means in same column by similar letters are not statistically different at 0.05 level according to Tukey test.

T1 - Control **T3 - potassium silicate**

T 2 - MAP (Modified atmosphere packaging) **T4 - potassium silicate + MAP**

silicate recorded the lowest contents of TA% (0.469, 0.375 % at ARRA15 and 0.394, 0.440% at ARRA18) followed by MAP(0.563, 0.300 % at ARRA15 and 0.469, 0.440% at ARRA18) and potassium silicate plus MAP (0.638, 0.488 % at ARRA15 and 0.544, 0.548% at ARRA18), while the lowest TA%(0.281, 0.225 % at ARRA15 and 0.300, 0.276% at ARRA18) were recorded by control berries after 5 weeks date in both seasons, respectively. On the other side, a decrease in berry TA% of (ARRA15 & ARRA18) table grape berries were observed up 5 weeks under cold storage conditions, in both seasons, respectively, for all treatments used. On discussing the previous results, decreasing in juice TA% with the enhancement of potassium levels could be due to the interact with tartaric acid to form of potassium tartarate which limited solubility (Davies, *et al.* 2006) and (Saleh *et al.* 2007) on "Thompson seedless " grape vines mentioned the role of potassium fertilization in reducing the acid levels in berries.

Total sugar percentage (TS %):-

As shown in Table 10 & 11 preharvest spraying application treatment by potassium silicate plus MAP at postharvest recorded the highest berry sugar percentage(20.65, 20.72% at ARRA15 and 18.40, 18.81% at ARRA18) followed by potassium silicate(19.85, 19.79% at ARRA15 and 18.11,18.36% at ARRA18) and MAP (18.59,19.20% at ARRA15 and 17.21,17.95% at ARRA18), while the lowest sugars percentage (15.37,15.87% at ARRA15 and 13.64, 14.21% at ARRA18) were recorded by control berries during cold storage in both seasons, respectively. On the other hand, increase in berry total sugars percentage of "ARRA15" and "ARRA18" grapes continued up to the end of cold storage conditions in both seasons for all treatments used. These results are in harmony with (Nofal and Rezk, 2009) reported that, potassium influence the flavor and taste of table grapes by increasing the sugar content and the sweetness of the berries. In the same line, (Kelany, *et al.* 2011) found that potassium as foliar application at preharvest had more pronounced positive effect on berry quality of "Flame seedless" during storage at 0 ^{o} C. Effective MAP to preserve berry appearance when storage time was prolonged up to 5 weeks.

The obtained results are similar to those obtained by (Hanumanthaiah, *et al.* 2015) declared that, spraying banana plants with potassium silicate as pre-harvest treatment significantly increased sugar contents (non-reducing sugar, reducing sugars) in banana compared with control. Also, the similar results obtained by (Bhavya, 2010) in Bangalore blue grapes and (El mehrat, *et al.* 2017) in mango fruits sprays by potassium silicate at preharvest increased total sugars in mango fruits. In this respect, Flame seedless sprays with silicon increased total sugars in grape berries (Bassiony and Manal, 2016).

Phenol contents in grape berries:

Free, conjugated and total phenols were estimated in grape berries as a reflection affect of potassium silicate on grape vines (ARRA 15 and ARRA 18) and storage for 35 days at 0°C and 90 - 95% RH after grape berries packaged in MAP or without. Data in Tables (12&13) reveal that, using potassium silicate affect phenol content compared with control treatment. The combination of potassium silicate and MAP or without increased phenol content (free and total phenols) in inoculated grape berries (ARRA 15 and ARRA 18) with *B. cinerea* and under natural infection conditions compared with control. But, they caused reduction in conjugated phenols of grape berries inoculated with *B. cinerea* compared with control.

Table (10): Effect of pre-and postharvest treatments on total sugar (TS %) of (ARRA15 & ARRA18) table grape berries stored at 0oC during 2016 season

Total Sugar%								
First season								
Times		0	1	2	3	4	5	Mean
(A) ARRA 15	T_1	14.41 a	16.65 a	17.55 b	18.78 ab	17.28 c	15.37 d	16.67 B
	T_2	14.41 a	15.45 bc	16.87 bc	17.96 bc	18.17 b	18.59 b	16.91 B
	T_3	14.22 a	15.87 ab	18.79 a	19.07 a	19.37 a	19.85 a	17.86 A
	T_4	14.22 a	15.77 abc	17.52 b	18.10 abc	19.47 a	20.65 a	17.62 A
(B) ARRA 18	T_1	14.47 a	15.68 abc	16.59 bc	17.25 cd	14.85 e	13.64 e	15.41 D
	T_2	14.47 a	14.79 c	15.17 d	15.60 ef	16.16 d	17.21 c	15.57 D
	T_3	14.37 a	15.04 bc	15.93 cd	16.41 de	16.81 cd	18.11 bc	16.11 C
	T_4	14.37 a	14.80 c	15.07 d	15.33 f	16.48 d	18.40 b	15.74 CD
Mean (A)		14.31 A	15.94 A	17.68 A	18.48 A	18.57 A	18.62 A	17.26 A
Mean (B)		14.42 A	15.08 B	15.69 B	16.15 B	16.08 B	16.84 B	15.71 B

Means in same column by similar letters are not statistically different at 0.05 level according to Tukey test.

T1 - Control
T 2 - MAP (Modified atmosphere packaging)
T3 - potassium silicate
T4 - potassium silicate + MAP

Table (11): Effect of pre-and postharvest treatments on total sugar (TS %) of (ARRA15 & ARRA18) table grape berries stored at 0°C during 2017 season

Total Sugar%								
Second season								
Times		0	1	2	3	4	5	Mean
(A) ARRA 15	T_1	14.71 a	15.39 a	16.77 a	19.50 a	17.45 c	15.87 e	16.61 BC
	T_2	14.71 a	15.12 a	16.71 ab	17.44 c	18.56 b	19.20 bc	16.96 AB
	T_3	14.53 a	15.55 a	16.40 abc	18.99 ab	19.34 ab	19.79 ab	17.43 A
	T_4	14.53 a	15.23 a	16.03 abc	18.45 b	19.59 a	20.72 a	17.43 A
(B) ARRA 18	T_1	14.48 a	15.47 a	15.79 abc	17.61 c	15.12 d	14.21 f	15.45 E
	T_2	14.48 a	15.09 a	15.47 c	15.95 d	17.01 c	17.95 d	15.99 D
	T_3	14.77 a	15.25 a	15.63 c	16.13 d	17.23 c	18.36 cd	16.23 CD
	T_4	14.77 a	15.12 a	15.47 c	15.87 d	17.07 c	18.81 bcd	16.18 CD
Mean (A)		14.62 A	15.32 A	16.48 A	18.60 A	18.73 A	18.89 A	17.11 A
Mean (B)		14.63 A	15.23 A	15.59 B	16.39 B	16.61 B	17.33 B	15.96 B

Means in same column by similar letters are not statistically different at 0.05 level according to Tukey test.

T1 - Control
T 2 - MAP (Modified atmosphere packaging)
T3 - potassium silicate
T4 - potassium silicate + MAP

Table (12): Effect of spraying potassium silicate salt as pre-harvest on phenol contents in (ARRA15 & ARRA18) table grape inoculated with B. cinerea and storage in MAP for 35 days season 2016.

Treatments		First season					
		phenols					
		Botrytis cinerea			Natural infection		
		Free	Conjugated	Total	Free	Conjugated	Total
(A) ARRA 15	T_1	5.23 e	0.74 c	5.97 d	1.56 h	1.85 c	3.41 e
	T_2	5.23 e	1.54 a	6.77 c	2.77 g	1.91 c	4.69 d
	T_3	6.85 b	0.24 e	7.09 a	4.41 f	2.27 a	6.68 b
	T_4	6.68 c	0.35 d	7.03 ab	4.94 d	1.99 b	6.93 a
(B) ARRA 18	T_1	5.32 f	0.70 c	6.02 cd	4.62 e	0.24 f	4.86 c
	T_2	5.97 d	0.80 b	6.77 c	5.47 c	1.52 d	6.99 a
	T_3	6.80 b	0.33 d	7.13 a	6.19 b	0.68 e	6.87 a
	T_4	6.97 a	0.11 f	7.08 ab	6.61 a	0.26 f	6.87 a
Mean (A)		6.00 A	0.72 A	6.72 A	3.42 B	2.01 A	5.43 B
Mean (B)		6.26 A	0.48 B	6.75 A	5.72 A	0.68 B	6.40 A

Means in same column by similar letters are not statistically different at 0.05 level according to Tukey test.

T1 - Control T3 - potassium silicate

T 2 - MAP (Modified atmosphere packaging) T_4 - potassium silicate + MAP

Table (13): Effect of spraying potassium silicate salt as pre-harvest on phenol contents in (ARRA15 & ARRA18) table grape inoculated with B. cinerea and storage in MAP for 35 days season 2017.

Treatments		Second season					
		phenols					
		Botrytis cinerea			Natural infection		
		Free	Conjugated	Total	Free	Conjugated	Total
(A) ARRA 15	T_1	6.20 d	0.71 c	6.91 d	1.50 h	1.81 d	3.31 f
	T_2	3.47 f	3.52 a	6.99 ab	2.74 g	1.88 c	4.62 e
	T_3	6.82 b	0.21 e	7.03 a	4.39 f	2.24 a	6.63 c
	T_4	6.66 c	0.34 d	7.00 ab	4.93 d	1.97 b	6.90 ab
(B) ARRA 18	T_1	6.08 d	0.62 c	6.70 ab	4.58 e	0.21 g	4.79 d
	T_2	5.95 e	0.78 b	6.73 c	5.43 c	1.48 e	6.91 a
	T_3	6.76 b	0.29 d	7.05 a	6.20 b	0.64 f	6.84 ab
	T_4	6.94 a	0.09 f	7.03 ab	6.56 a	0.23 g	6.79 b
Mean (A)		5.79 B	1.19 A	6.98 A	3.39 B	1.98 A	5.37 B
Mean (B)		6.43 A	0.45 B	6.88 A	5.69 A	0.64 B	6.33 A

Means in same column by similar letters are not statistically different at 0.05 level according to Tukey test.

T1 - Control T3 - potassium silicate

T2 - MAP (Modified atmosphere packaging) T4 - potassium silicate + MAP

In this respect, MAP was highly effective in increasing phenol contents (conjugated and total phenols) in inoculated grape berries (ARRA 15 and ARRA 18) with *B. cinerea* and free, conjugated and total phenols in natural infection grape berries. On the other hand, MAP was least effective in increasing free phenols of grape berries (ARRA 15 and ARRA 18), where, it caused reduction in free phenols of berries inoculated with *B. cinerea* compared with control. While, the highest phenols content (7.09,7.03 and 7.13, 7.05 mg/g fw for total phenols) were recorded in treated with potassium silicate post inoculation with *B. cinerea* on grape berries ARRA 15 and ARRA 18,in both seasons, respectively*.* As well as, (6.68, 6.66 and 6.97, 6.94 mg/g fw for free and total phenols) were recorded in the combined treatment of potassium silicate and MAP post inoculation with *B. cinerea* grape berries ARRA 15 and ARRA 18, in both seasons, respectively. (Shetty *et al* 2011) reported that, the mode of Si action in controlling rose diseases is by increased production of antifungal phenolic compounds. On the other hand, pre- harvest application with Si include the increased production of phenolic compounds, phytoalexins and lignin associated with plant resistance to diseases, (Liang, *et al.* 2005) and (Lima, *et al.* 2010).

Anthocyainin (mg/100gm f. W.):

Data in Table (14) reveal that anthocyainin (mg/100gm f.w.) was increased with the advance in cold storage up to 5 weeks. Spraying table grape clusters by potassium silicate and packaging in MAP gave the highest values of anthocyainin (33.48, 37.92 mg/100gm f. w.), flowed by potassium silicate without packaging (32.72, 37.15 mg/100gm f.w.), while the least value was recorded by control treatment (21.28, 22.20 mg/100gm f.w.) in the both seasons, respectively. On the other side, untreated by potassium silicate and packaging in MAP increased berry anthocyainin. It recorded (31.09, 37.08 mg/100gmf.W.) in the both seasons, respectively.

Table (14): Effect of pre-and postharvest treatments on Anthocyainin mg/100g f.w of (ARRA18) table grape berries stored at 0oC during2016 & 2017 seasons

Anthocyainin mg/100g fw								
ARRA 18								
Times		0	1	2	3	4	5	Mean
First season	T_1	18.94 a	24.10 a	26.04 a	26.60 a	22.61 a	21.28 b	23.26 B
	T_2	18.94 a	20.91 b	22.81 b	23.79 c	27.83 a	31.09 a	24.23 AB
	T_3	17.58 a	21.86 b	24.71 ab	26.04 b	27.70 a	32.72 a	25.10 A
	T_4	17.58 a	21.93 b	24.03 ab	25.97 b	29.53 a	33.48 a	25.25 A
Second season	T_1	19.79 a	24.75 a	26.65 a	26.82 a	23.15 b	22.20 b	23.89 B
	T_2	19.79 a	21.52 b	24.13 a	25.83 c	29.74 a	37.08 a	26.35 A
	T_3	18.94 a	21.38 b	26.07 a	27.73 b	30.11 a	37.15 a	27.01 A
	T_4	18.94 a	22.27 b	24.64 a	26.68 bc	30.75 a	37.92 a	26.87 A

Means in same column by similar letters are not statistically different at 0.05 level according to Tukey test.

T1 - Control

T2 - MAP (Modified atmosphere packaging)

T3 - potassium silicate

T4 - potassium silicate + MAP

On discussing the previous results, in case of ARRA18 grape the coloration is due to anthocyainin accumulation in the skin, begging at version stage (the onset of maturation stages). Same results are shown by (Rizk-Alla and Meshrake, 2006) found that, preharvest application on "Crimson seedless" cv. By potassium lead to anthocyainin increasing.

Conclusion

Overall results indicate that MAP in combination with potassium silicate to extent storage period of table grapes seems to be the best method, potassium silicate spraying application enhanced berry firmness while MAP slows down the respiration of commodity. Such combined effect would enhance the storage period of grapes by efficiently delaying reduction of fresh weight, TSS, TS, berry decay. In the combined use potassium silicate is expected to sanitize the berry surface while MAP retards tissue senescence by restricting respiration rate of the berries.

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تأثير الرش بسيليكات البوتاسيوم مع التغليف علي القدرة التخزينية و مقاومة أمراض ما بعد الحصاد لثمار العنب

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الملخص العربى

أجريت التجربة خلال موسمين متتاليين ٢٠١٦ ، ٢٠١٧ علي صنفين من أصناف العنب الجديدة أرا ١٥، أرا ١٨ المنزرعة في الأراضي الرملية بمدينة السادات – محافظة المنوفية – مصر لدراسة تأثير الرش بسيليكات البوتاسيوم قبل الحصاد والتعبئة في أكياس الجو المعدل علي الجودة والقدرة التخزينية والتسويقية ومكافحة أمراض ما بعد الحصاد لثمار العنب.

أوضحت النتائج إلي أن معاملات سيليكات البوتاسيوم والتعبئة في أكياس الجو المعدل منفردة أو مجتمعة أدت إلي الحفاظ علي جميع صفات الجودة والقدرة التخزينية والتسويقية ومقاومة أمراض ما بعد الحصاد لثمار العنب طوال فترة التخزين (٥ أسابيع) مقارنة بالثمار التي لم تعامل سواء رش أو تغليف (كنترول) التي فقدت جودتها التخزينية والتسويقية ومقاومة أمراض ما بعد الحصاد خلال ٣ أسابيع من التخزين المبرد.

أعطت معاملة الرش بسيليكات البوتاسيوم مع التعبئة في أكياس الجو المعدل أفضل صفات للجودة والمحافظة علي القدرة التخزينية والتسويقية ومقاومة أمراض ما بعد الحصاد.

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