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EFFECT OF SOME PRE-HARVEST TREATMENTS ON IMPROVING QUALITY AND STORABILITY OF CRIMSON SEEDLESS GRAPES.

BY

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ABSTRACT

The effect of 1% calcium chloride, 2% calcium nitrate, 1% calcium Edeta and 0.4% zinc sulfate as foliar spraying on improving quality and storability of Crimson Seedless grape fruits was studied during 2002 and 2003 seasons .The clusters were sprayed with 1% $CaCl_2$, 2% $Ca(NO_3)_2$ 1% Ca- Edeta and 0.4% Zn SO_4 one month before harvest and then stored after harvest at 0°c and 90 – 95 % RH . Moreover, treated clusters were examined every 2 weeks to study the physical and chemical properties during the storage period. The results indicted that the storability of treated clusters was increased comparing with the untreated clusters. $Ca(NO_3)_2$ treatment prolonged storage period till 165 days while $CaCl_2$, Ca-Edeta and $ZnSO_4$ treatments stayed fruits until 150 days, as compared with the control which stayed only 120 days in the cold storage. Also, all pre-harvest treatments decreased decay %, weight loss %, and acidity % as well as increased the berry adherence, firmness, besides TSS %, total sugars and anthocyanin contents under cold storage period and shelf life after storage . It can be concluded that, best treatments with the favorable characteristics of Crimson clusters were obtained from treating clusters with 2% $Ca(NO_3)_2$ one month before harvest .

INTRODUCTION

Crimson Seedless cv. is a late- season and red table grape . It developed by David Ramming and Ron Tarailo of the USDA fruit Genetics and Breeding Research Unit, Fresno, CA, (Romming *et al.*, 1995) Crimson Seedless cultivar previously known as selection # 102 – 26, resulted from a cross of Emperor x selection # C_{33-199} .It appeared from five generations of crossing which accomplished among several parents, i.e. Emperor, Thompson Seedless, and Calmeria cultivars.

Crimson Seedless berries are similar in size and shape to Thompson Seedless cultivars, and developed a bright red color berries at harvesting. Moreover, it has superior eating characteristics: berry texture i.e. firmness and crisp as well as its excellent flavor.

Furthermore Crimson Seedless is one of the most important table grape cultivars in the world. It holds significant promises for producers and exporters due to its late maturity, which required for creating more chances for successful exportation. Revions review indicate that Singh and Ranjit (1990) reported that pre-harvest application of 1% calcium nitrate and 0.2% zinc sulfate on Delight grapes reduced the incidence of berry drop, berry rot and total spoilage during storage Lu and Duyang, (1990) mentioned that grapevines were sprayed 10 days before harvesting with calcium nitrate (1%) or zinc sulfate (0.2%) or both reduced berry rot during storage. Highest concentrations of $Ca(NO_3)_2$ 1.5%increased the pressure and strength attachment of berries. Khitron and Lyublinskaya (1992) showed that 1.2% $CaCl_2$ applied to grape cultivars i.e., Muscat Hamburg, Moldova and Italy gave the best results of storage decay beside no fungicide residues after 3 months of storage.

Whereas, Waskar *et al.* (1994) found that Thompson Seedless grapevines treated with 0.6% $CaCl_2$ had low level of berry weight loss and long shelf life . Furthermore, Babalar *et al.* (1999) exhibited that two grape cultivars, Keshmeshy Bidanch and Shahroudy, sprayed with (0,2,4%) $CaCl_2$ had reduced decay, and significantly influenced fruit TSS and weight loss. Moreover, Lima *et al.*, (2000) studied the effect of pre-harvest spray of 1.5 % $CaCl_2$ at the initial phase of color change and softening of berries on storage quality of grape cv. Italia which decreased total soluble solids (TSS), total titratable acidity, (TTA) and prolonged storage life of the grapes to 56 days.

So the present study was carried out as a trial to improve fruit quality and storability to prolong marketing season of Crimson seedless grape cultivar via pre-harvest treatments besides studying physical and chemical characteristics changes during storage. Thus, these treatments will open a new window for Egyptians to successful exportation of this cultivar.

MATERIALS AND METHODS

This investigation was carried out during two successive seasons of 2002 and 2003 on four years old Crimson Seedless grapevine grown in EL-Sadat region, Menofiya Governorate. The vines were planted at 3x3 meters apart (466 vine/feddan) in sandy soil under drip irrigation system. The vines were trained and pruned in "Tetra-Cardoon" shape and trellised on Spanish Baron system. Canes were pruned each season in the 3rd week of Jan. with 6 buds/cane and total of 72 buds/vine. Also cluster thinning was done at 30 clusters per vine, each one shorted to 14-15 cm and had 80-100 berries per cluster two weeks after berry set. The vines were nearly similar in vigor, healthy from disease and pests and received all horticultural practices. The experiment contained foruty five vines divided between four treatments beside the control. Each replicated three times, these vines were treated with a randomized complete block design. Any how this study was arranged as factorial experiment. All clusters were sprayed 1 month before harvesting with 1% calcium chloride ($CaCl_2$), calcium Edeta, 2% calcium nitrate $Ca(No_3)_2$ and 0.4% zinc sulfate ($ZnSO_4$).

The vines were harvested during the first week of October in both season when the TSS reached 16% and the red color covered all the berries surface as mentioned by (EL Hammady *et al.*, 1998).

The clusters immediately packed gently in perforated carton boxes exhibited under pre-cooling at 4-5 °C and cold stored (0°C with 90-95 % RH) . In this concern each treatment contained 9 boxes devoted into 3 replicates for each box, the first box deviled for the periodical determination of weight loss while the second one for studying the decay percentage and the third box for the determination of the physical and chemical properties of berries . Samples were taken every 2 weeks to be analyzed for both physical and chemical characteristics during all period of storage. Fruits of any treatment reached in to 50 % decay, were excluded. After storage period of other treatments or the control fruits were transferred to room temperature for studding shelf life of fruits.

Fruit Quality And Cold Storage Studies :

Determination Of Physical and Chemical Properties

1- Fruit physical properties:

Fruit decay %

Decay berries percentage was calculated as follow:

$$\text{Decay \%} = \frac{\text{Decayed berries (g)}}{\text{Inital weight (g)}} x100$$

Weight loss %

Calculated as follow:

$$\text{Weight loss \%} = \frac{\text{Loss in fruit weight (g)}}{\text{Fruit weight at the beginning of storage (g)}} x100$$

Adherence strength (g)

Berry adherence force (g) measured by using scale and force meter instrument.

Berry firmness (g)

Berry firmness was determined by using Shatilon's instrument for measuring firmness for grape, average of all berry firmness was recorded as (g/cm^2)

2- Fruit chemical properties

Total soluble solids (TSS%)

Ahand refrectometer was used to determine the total soluble solids percentage in berry juice (A. O. A. C., 1990)

Total acidity

Total acidity content was determined by titration with a standard solution for sodium hydroxided (0.1 N) using phenol phythalin as an indicator, the results were expressed as percentages of anhydrous tartaric acid.

$$\text{Total acidity} = \frac{\text{ml of NaOH} \times N \times 0.075}{\text{ml juice used}} x100$$

according to the method described by (A.O.A.C., 1990).

Total sugars

Total sugars were determined by using the phenol sulfuric acid method (Smith *et al.*, 1956) while the concentration was calculated from a standard curve of glucose as mg. per g. fresh weight.

Total anthocyanin

Total anthocyanin content of berry (mg/g F.W) was estimated to according the method described by (Yilids and Dikmen, 1990).

Statistical Analysis

All obtained data were statistically analyzed using a factorial in randomized complete design according to Steel and Torrie (1980). Means of treatments were compared by the least significant difference test (L.S.D) at the 0.05 level.

RESULTS AND DISCUSSION

1 Physical characteristics

1-1 Decay percentage

Results Tables (1 & 2) clear that decay percentage was increased considerably with prolonged storage period in all treatments, as well as the control in both seasons. As a general role, any treatment was terminated when its percentage of decay reached a bout 50% in this respect, (Melero & Lizana 1988) reported that decay in stored grapes was increased gradually with advanced storage. It could be noticed that, there were differences in storage period between treatments whereas clusters treated with 2% $Ca(NO_3)_2$ elongated storage period of cluster till 165 days, while treatments of $CaCl_2$ at 1% and Ca-Edeta at 1% and $ZnSO_4$ at 0.4% prolonged the storage period to 150 days as compared with the control which ended after 120 days in both seasons. As shown Gupta *et al.* (1980) reported that application with $Ca(NO_3)_2$ at 1%,10 days before harvest at 1% on Prelates grapes significantly reduced decay in stored grapes . Similar result were obtained by Singh and Ranjit (1990) & Lu and Duyang (1990) they reported that pre-harvest treatment of grapevines were Sprayed with (1%) calcium nitrate or (0.2 %) Zinc sulfate before harvesting had reduced berry rot during storage .

Also, Khitron *et al.* (1992) showed that $CaCl_2$ at 1.2 % applied to grape cultivars i.e., Muscat Hamburg, Moldova and Italy gave the best results of storage decay beside no Fungicide residues after 3 months of storage.

Also, results that the lowest values for decay percentage were obtained as a result of the combination for spraying the cluster with 2% $Ca(No_3)_2$ one month pre-harvest and storage it at 0 °C for 120 day where 29.7% compared with other tested treatments and the control one .

Table (1): Effect of calcium and zinc treatments on decay % of "Crimson Seedless" grapes during cold storage at 0°C (2002 season).

Storage period in days (P) / Treatment (T)	0	15	30	45	60	75	90	105	120	135	150	165	Mean
Control	0	3.2	5.6	9.2	14.7	24.5	33.6	44.7	53.4				20.9
CaCl 2 1%	0	2.4	3.3	5.7	7.6	11.5	20.5	26.6	33.8	43.7	50.5		18.6
$Ca(No_3)_2$ 2%	0	1.2	2.1	3.5	5.8	10.5	19.6	24.7	29.7	34.7	41.8	49.7	18.6
Ca-Edeta 1%	0	2.6	3.9	6.1	7.96	12.8	20.6	26.8	34.5	44.6	52.1		19.2
$ZnSO_4$ 0.4%	0	2.6	4.0	6.2	8.16	13	20.9	27.4	34.5	46.5	52.5		19.6
Mean	0	2.4	3.8	6.14	8.84	14.5	23	30	37.2	44.6	50.1	49.7	

L.S.D. at 0.05 for T 0.65 P 0.62 T xP 0.85

Table (2): Effect of calcium and zinc treatments on decay % of "Crimson Seedless" grapes during cold storage at 0°C (2003 season).

Storage period in days (P) / Treatment (T)	0	15	30	45	60	75	90	105	120	135	150	165	Mean
Control	0	2.6	4.6	8.6	15.8	23.8	32.0	43.4	51.4				20.2
CaCl 2 1%	0	1.5	3.8	6.8	9.3	12.4	21.5	27.9	34.5	44.9	50.5		19.3
$Ca(No_3)_2$ 2%	0	0	2.2	4.3	6.3	11.5	18.9	23.6	30.5	35.4	42.7	50.8	18.8
Ca-Edeta 1%	0	18	3.8	6.8	9.5	12.5	22.4	28.3	34.3	44.6	52.3		19.6
$ZnSO_4$ 0.4%	0	2.2	4.1	6.7	8.4	13.5	22.9	29.1	35.5	45.3	52.8		20.0
Mean	0	4.8	3.7	6.6	9.8	14.7	23.5	30.5	37.2	44.3	49.5	50.8	

L.S.D at 0.05 for T 0.43 P 0.50 T Xp 0.61

1-2 Weight loss%

Tables (3 & 4) showed the percentage of weight loss in Crimson Seedless grapes during cold storage for the two seasons. It was clear that loss in fruit weight was increased as storage period advanced. The highest weight loss was obtained at the end of storage for all treatments used being (6.72 & 7.56 %) in both seasons, respectively. Abo–Shanab (1977) found that, weight loss percentaging was increased gradually with prolonged storage period .Similar trend was obtained by Mohamed (1980), El–Banna *et al.* (1984a) and Wassel

(1985). Moreover, the present data reveale that $Ca(NO_3)_2$ at 2% recorded the lowest significant percentage of fruit weight loss being (3.13% & 3.52 %) in both seasons, respectively, as compared with the control which gave the highest significant percentage of weight loss being (4.79% & 5.40 %) during 2002 and 2003 seasons, respectively. These results agree with Subbramu *et al.* (1990) they indicated that pre-harvest spray of 1% calcium nitrate and 0.6% calcium chloride applied to Muscat grapes 20 days before harvest and grapes and stored under ambient conditions, reduced weight loss in fruits . Also, Waskar *et al.* (1994) reported that 0.6 % $CaCl_2$ pre-harvest treatment on stored grape cv. Thompson seadless had low level of berry weight loss .

Table (3): Effect of calcium and zinc treatments on weight loss %of "Crimson Seedless" grapes during cold storage at 0°C (2002 season).

Storage period in days (P) Treatment (T)	0	15	30	45	60	75	90	105	120	135	150	165	Mean
Control	0	1.86	2.3	3	3.6	4.6	5.36	5.96	6.6	7.33	7.83	8.46	4.74
CaCl 2 1	0	1.6	2.2	2.5	2.9	3.33	3.83	4.5	4.9	5.3	5.86	6.26	3.6
$Ca(No_3)_2$ 2%	0	1.4	1.73	2.2	2.53	2.76	3.26	3.7	4.26	4.83	5.25	5.6	3.13
Ca-Edeta 1%	0	1.6	2.26	2.56	3.16	3.7	4.3	4.83	5.26	5.63	6.13	6.43	3.82
$ZnSO_4$ 0.4%	0	1.8	2.33	2.73	3.33	3.86	4.46	5.1	5.46	6.1	6.46	6.83	4.04
Mean	0	1.65	2.16	2.6	3.1	3.65	4.24	4.82	5.3	5.84	6.31	6.72	

L.S.D at 0.05 for T 0.464 P 0.413 T x P 0.351

Table (4): Effect of calcium and zinc treatments on weight loss % of "Crimson Seedless" grapes during cold storage at 0°C (2003 season).

Storage period in days (P) Treatment (T)	0	15	30	45	60	75	90	105	120	135	150	165	Mean
Control	0	2.50	2.86	3.83	4.56	5.30	5.93	6.76	7.53	7.83	8.43	9.23	5.40
CaCl 2 1%	0	1.80	2.30	2.76	3.26	3.70	4.40	5.23	5.70	6.20	6.66	7.06	4.09
$Ca(No_3)_2$ 2%	0	1.60	2.10	2.50	2.66	3.30	3.70	4.13	4.66	5.20	5.86	6.56	3.52
Ca-Edeta 1%	0	2.06	2.46	2.96	3.50	4.00	4.66	5.50	5.90	6.36	6.90	7.26	4.30
$ZnSO_4$ 0.4%	0	2.23	2.66	3.23	3.73	4.26	4.86	5.70	6.16	6.63	7.13	7.70	4.52
Mean	0	2.04	2.48	3.06	3.54	4.11	4.71	5.46	5.99	6.44	7.00	7.56	

L.S.D at 0.05 for T 0.394 P 0.336 T x P 0.307

As for the effect of interaction between the tested treatment and storage period, the same data at Tables (3 & 4) refer that the lowest value for weight loss in fruit at different sampling time i.e. 15.30.45 up to 165 days of storage was connected with spraying the clusters with $Ca(NO_3)_2$ at 2 % compared with other treatments during both seasons of study.

1-3 Berry adherence:

Berry adherence of Crimson Seedless grape cv. during cold storage at 0°C and 90 – 95% RH decreased towards the end of storage period Tables (5 & 6). The obtained results are in agreement with the findings of Wassel (1985) who reported that berry adherence decreased during prolong storage of grapes.

Furthermore, $Ca(NO_3)_2$ at 2% gave the highest significant berry adherence (221.6g & 273.7g) followed by $CaCl_2$ at 1% treatment which had value of (203.7 & 261.7 g), Ca-Edeta 1% treatment which gave (192.8 g & 246.9g) and finally $ZnSo_4$ 0.4% treatment which gave (182.1 & 217.0 g) as compared with the control (146.1 & 186.0g) in both seasons. It could be concluded that the increase in berry adherence strength as a result of Ca treatments may be attributed to the role of Ca^{2+} in building of cell wall and middle lamella and consequently in increasing adherence of treated berries (Hepler & wayne, 1985) On the other hand, Lu and Duyang (1990) report that pre-harvest treatment with $Ca(NO_3)_2$ 1.5% gave increment increased in the strength attachment.

Concerning the interaction, data in Tables (5 & 6) indicate that the highest berry adherence at different periods of sampling during the storage was recorded as a result of calcium treatments especially $Ca(NO_3)_2$ at 2 % compared with other treatments during both seasons of study.

Table (5): Effect of calcium and zinc treatments on berry adherence (g) of "Crimson Seedless" grapes during cold storage at 0°C (2002 seasons).

Storage period in days (P) / Treatment (T)	0	15	30	45	60	75	90	105	120	135	150	165	Mea
Control	210.0	200.9	189.7	178.8	166.9	155.3	143.3	130.9	116.4	102.6	89.3	69.9	146.1
CaCl2 1%	275.0	265.3	253.3	240.0	225.6	211.7	196.5	182.8	169.6	155.3	142.4	127.0	203.7
$Ca(No_3)_2$ 2%	286.0	277.6	266.9	254.0	243.3	230.0	218.0	204.5	190.0	177.6	163.3	148.6	221.6
Ca-Edeta 1%	260.0	250.0	239.0	228.6	216.4	203.2	189.3	174.4	160.5	145.6	130.7	115.9	192.8
$ZnSO_4$ 0.4%	250.0	239.3	227.0	215.0	202.0	190.6	178.5	165.5	151.7	137.3	122.5	106.7	182.1
Mean	256.2	244.2	232.5	220.4	208.0	195.1	182.3	168.9	154.7	141.1	126.5	128.9	

L.S.D at 0.05 for T 9.51 P 11.24 T x P 13.78

Table (6): Effect of calcium and zinc treatments on berry adherence (g) of "Crimson Seedless" grapes during cold storage at 0°C (2003seasons).

Treatment (T) \ Storage period in days (P)	0	15	30	45	60	75	90	105	120	135	150	165	Mean
Control	260.0	248.3	236.5	223.5	209.6	195.8	181.9	166.7	151.8	136.3	120.5	101.3	186.0
CaCl 2 1%	325.0	316.6	305.6	295.7	283.6	270.9	265.4	243.6	229.3	215.8	201.7	187.9	261.7
Ca(No3)2 2%	340.0	329.6	318.5	306.5	294.3	281.5	269.5	256.3	243.6	229.4	215.9	200	273.7
Ca-Edeta 1%	318.0	306.7	295.8	232.6	268.3	255.8	241.6	226.7	214.5	199.6	184.3	166.8	242.7
ZnSO4 0.4%	288.0	276.5	263.9	251.8	238.6	224.6	211.9	197.5	184.5	170.6	156.9	140.8	217.0
Mean	304.0	293.3	282.0	259.6	256.34	244.6	229.7	215.7	202.0	187.5	172.9	174.1	

L.S.D at 0.05 for T 8.76 P 10.03 T x P 12.09

1-4 Firmness

As shown in Tables (7 & 8), it is clear that the average values decreased as the storage period increased reaching its lowest values at the end of storage. The present results agree with the findings of Kokkalos (1986) who reported that there was a decrease in firmness readings with advancing storage period of grapes. In addition, calcium treatments gave the highest values of firmness as compared with zinc treatment and the control. The highest values of berry firmness obtained from $Ca(NO_3)_2$ treatment (1560 & 1591 g/cm^2) followed by $CaCl_2$ (1489 & 1532g/cm^2 followed by Ca-Edeta (1414 & 1490 g/cm^2) and by $ZnSO_4$ (1360 & 1422/cm^2) in descending order as, compared with the control treatment (811 & 1037g/cm^2) in both seasons. The increase in berry firmness is considered as one of the most important traits of quality during transport, handling and storage (Shear, 1975). These result are in accordance with Singh and Ranjit Kumar (1989) The studied that pre-harvest spray of $Ca(NO_3)_2$ or 0.2% $ZnSo_4$ were applied to Delight grapes 10 days before harvest whereas grapes remained firm for 18 days in cold storage as compared with 6 days for the control. Also, Siddiqui and Bangerth (1995) mentioned that pre-harvest treatment for apple trees 1 month after set with 1.2% $CaCl_2$ increased the degree of fruit firmness at harvest and after 3 weeks of storage. Meanwhile, Kumar *et al.* (1990) mentioned that grapes which has been sprayed with 1% $Ca(NO_3)_2$ at 10 days before harvest and stored in cold storage (0 °c) and 90% RH were higher in Ca content. Also, Lu and Duyang (1990) reported that grapes were sprayed 10 days or 1 month before harvest with $Ca(No_3)_2$ 1.5 % had increased the pressure.

Regarding the effect of spray treatments on firmness character data in Tables (7 & 8) show clearly that there were significant differences among the tested treatments on such character. In this respect, the highest values were recorded as result of using calcium compounds compared with zinc and control treatments. Such results were true during both season of study.

Table (7): Effect of calcium and zinc treatments on firmness g/cm^2 of "Crimson Seedless" grapes. during cold storage at 0°C (2002 season).

Storage period in days (P) / Treatment (T)	0	15	30	45	60	75	90	105	120	135	150	165	Mean
Control	1100	1060	1010	965	910	860	800	745	680	610	530	465	811
CaCl 2 1%	1790	1750	1700	1650	1590	1540	1490	1430	1340	1280	1200	1110	1489
$Ca(No_3)_2$ 2%	1850	1813	1773	1730	1670	1620	1560	1500	1430	1360	1250	1185	1560
Ca-Edeta 1%	1700	1650	1600	1550	1505	1450	1400	1340	1290	1230	1160	1090	1414
$ZnSO_4$ 0.4%	1630	1590	1550	1500	1455	1405	1345	1295	1235	1175	1110	1030	1360
Mean	1614	1573	1527	1479	1426	1375	1319	1262	1195	1131	1050	976	

L.S.D at 0.05 for T 56.351 P 62.34 T x P 71.95

Table (8): Effect of calcium and zinc treatments on firmness g/cm^2 of "Crimson Seedless" grapes. during cold storage at 0°C (2003 season).

Storage period in days (P) / Treatment (T)	0	15	30	45	60	75	90	105	120	135	150	165	Mean
Control	1350	1305	1265	1215	1160	1105	1045	980	910	820	725	560	1037
CaCl 2 1%	1820	1790	1745	1690	1635	1585	1523	1460	1400	1330	1250	1160	1532
$Ca(No_3)_2$ 2%	1890	1845	1795	1745	1690	1635	1575	1510	1450	1390	1325	1245	1591
Ca-Edeta 1%	1770	1730	1685	1640	1590	1540	1490	1435	1360	1300	1220	1130	1490
$ZnSO_4$ 0.4%	1700	1660	1615	1565	1510	1460	1410	1350	1290	1230	1170	1100	1422
Mean	1890	1845	1795	1745	1690	1635	1575	1510	1450	1390	1325	1245	1591

L.S.D at 0.05 for T 58.5 P 66.0 T x P 81.2

In addition, at 2% reflected the higher value in this respect with regard to the effect of the interaction, the same data in Tables (7 & 8) prove that $Ca(No_3)_2$ treatment reflected the highest firmness for berries during the different periods of storage in two seasons of study.

2 Chemical characteristics

2-1 Total soluble solids (TSS)

Total soluble solids content of stored fruits as recorded in Tables (9 & 10) were gradually and significantly increased with the extend of storage period in the two seasons. Thus, the highest values of total soluble solids (21.2 % & 21.7%) were observed at the end of storage during 2002 & 2003 seasons, respectively. Clusters treated with calcium treatments appeared to an increase in fruit content of TSS % followed by zinc treatment, In this respect $Ca(NO_3)_2$ 2% treatment gave the highest values (20.2 & 20.7%) followed by $CaCl_2$ 1% (19.6 & 20.0%),Ca-Edeta 1% (19.2 & 19.7%) and $ZnSo_4$ 0.4% (18.9 & 19.4%) in descending order as compared with the control treatment which gave (18.1% & 18.5%) in both seasons. In this concern it could be concluded that fruit chemical quality was obvious affected with pre–harvest applications of Ca and Zn treatments .In this respect, Abd El – Halim (1981) and El – Banna, *et al.*, (1984b) reported that total soluble solids increased with the advanced storage period to reach its maximum at the end of storage. It is well clear that increasing TSS % was very important to fruit quality of grapes, probably due to water loss in fruits. On the contrary, Lima *et al.*, (2000) reported that pre-harvest spray of 1.5% $CaCl_2$ at the initial phase of color change and softening of berries of stored grape cv. Italia had decreased total soluble solids (TSS).

On the other hand, Babalar *et al.*, (1999) reported that two grape cultivars, Keshmeshy Bidanch and Shahroudy, sprayed with (0, 2 and 4 %) $CaCl_2$ had significantly influenced fruit TSS.

Concerning the interaction effect it is obvious from data in Tables (9 & 10) that TSS % was differ among the studied treatments and the control one during both seasons of study along the storage period. In this respect, $Ca(No_3)_2$ treatment at 2% gives the highest T.S.S.% during the different sampling time.

Table (9): Effect of calcium and zinc treatments on T.S.S % %of "Crimson Seedless" grapes during cold storage at 0°C (2002 season).

Storage period in days (P) Treatments (T)	0	15	30	45	60	75	90	105	120	135	150	165	Mean
Control	16.3	16.7	17.0	17.4	17.8	18.1	18.4	18.6	18.9	19.3	19.6	19.9	18.1
CaCl 2 1%	17.6	17.9	18.3	18.7	19.1	19.5	19.9	20.3	20.6	20.9	21.3	21.6	19.6
Ca(No3) 1%	18.0	18.4	18.8	19.3	19.6	20.0	20.5	21.1	21.4	21.7	22.0	22.4	20.2
Ca-Edeta 1%	17.3	17.5	17.8	18.2	18.7	19.2	19.5	19.9	20.3	20.6	20.9	21.3	19.2
ZnSO4 0.4%	17.0	17.3	17.6	17.9	18.4	18.8	19.2	19.5	19.8	20.2	20.5	20.8	18.9
Means	17.2	17.5	17.9	18.3	18.7	19.12	19.5	19.8	20.2	20.5	20.86	21.2	

L.S.D at 0.05 for T 0.403 P 0.482 T x P 0.557

Table (10): Effect of calcium and zinc treatments on T.S.S % of "Crimson Seedless" grapes during cold storage 0°C (2003 season).

Storage period in days (P) Treatments (T)	0	15	30	45	60	75	90	105	120	135	150	165	Mean
Control	16.7	17.0	17.3	17.7	18.8	18.4	18.7	18.9	19.3	19.7	20.1	20.4	18.5
CaCl2 1	17.9	18.2	18.6	19.0	19.4	19.8	20.2	20.7	20.9	21.5	21.8	22.0	20.0
Ca(No3) 1%	18.4	18.7	19.1	19.6	20.2	20.7	21.2	21.6	21.9	22.2	22.5	22.8	20.7
Ca-Edeta 1%	17.6	17.9	18.3	18.7	19.3	19.6	20.0	20.4	20.7	21.2	21.6	21.9	19.7
ZnSO4 0.4%	17.4	17.7	18.1	18.4	18.8	19.3	19.6	20.0	20.3	20.7	21.1	21.4	19.4
Means	17.6	17.9	18.2	18.6	19.3	19.5	19.9	20.2	20.6	21.0	21.4	21.7	

L.S.D at 0.05 for T 0.321 P 0.446 T x P 0.523

3-2-2 Total acidity

Data tabulated in Tables (11 & 12) showed that total acidity (TA) was significantly with prolonging cold storage periods. These results agree with the findings of Takeda (1983) who found that, after ten weeks of grape storage at 32° F chemical constituents of berry juice slightly changed during cold storage. Moreover, It could be noticed that $Ca(NO_3)_2$ treatment gave the lowest value of acidity (0.57% & 0.62 %) in both season respectively. It seems that fruit grape respiration consumed higher rates of acids since total acidity was reduced with prolonging cold storage period.

Table (11): Effect of calcium and zinc treatments on total acidity %of "Crimson Seedless" grapes. during cold storage at 0°C (2002 season).

Storage period in days (P) Treatment (T)	0	15	30	45	60	75	90	105	120	135	150	165	Mean
Control	0.81	0.78	0.75	0.72	0.70	0.68	0.65	0.62	0.58	0.53	0.52	0.51	0.65
CaCl2 1	0.76	0.74	0.71	0.67	0.63	0.60	0.56	0.53	0.50	0.48	0.46	0.43	0.59
$Ca(No_3)_2$ 2%	0.74	0.71	0.69	0.66	0.61	0.59	0.53	0.50	0.47	0.46	0.42	0.41	0.57
Ca-Edeta 1%	0.77	0.75	0.72	0.70	0.67	0.62	0.59	0.58	0.52	0.50	0.46	0.44	0.61
$ZnSO_4$ 0.4%	0.78	0.77	0.73	0.71	0.64	0.63	0.61	0.61	0.57	0.55	0.53	0.48	0.63
Mean	0.77	0.75	0.72	0.69	0.65	0.62	0.59	0.57	0.53	0.50	0.48	0.45	

L.S.D at 0.05 for T 0.033 P 0.0265 T x P 0.0213

As for the combined effect on total acidity, the same data in Tables (11 & 12) show that the lowest (TA) percentage during the hole period of experiment was recorded as a result of spraying cluster with $Ca(No_3)_2$ 2% once at one month before harvesting during the two seasons of study. These findings are in agreement with Turky (1996) who reported that spraying Thompson Seedless grape 1% with $CaCl_2$ and 1% $Ca(NO_3)_2$ at 2 weeks before harvest had a significantly decrease grape total acidity content during storage, this trend was also reported by Lima *et al.*, (2000).

Table (12): Effect of calcium and zinc treatments on total acidity %of "Crimson Seedless" grapes. during cold storage at 0°C (2003 season).

Storag perio in days (P Treatment (T)	0	15	30	45	60	75	90	105	120	135	150	165	Mean
Control	0.88	0.86	0.83	0.79	0.77	0.75	0.70	0.67	0.64	0.61	0.60	0.55	0.72
CaCl 2 1%	0.81	0.77	0.75	0.72	0.72	0.68	0.63	0.61	0.56	0.53	0.51	0.51	0.65
$Ca(No_3)_2$ 2%	0.75	0.73	0.71	0.70	0.66	0.63	0.60	0.57	0.55	0.53	0.52	0.50	0.62
Ca-Edeta 1%	0.78	0.77	0.75	0.73	0.71	0.67	0.65	0.64	0.60	0.57	0.54	0.52	0.66
$ZnSO_4$ 0.4%	0.82	0.80	0.78	0.75	0.72	0.70	0.77	0.65	0.63	0.59	0.56	0.55	0.69
Mean	0.81	0.79	0.76	0.74	0.72	0.69	0.67	0.63	0.60	0.57	0.55	0.53	

L.S.D at 0.05 for T 0.0541 P 0.0311 T x P 0.0253

2-3 Total Sugars

It is a clear from Tables (13 & 14) that total sugars increased with increasing the period of cold storage reaching the maximum values (159.92 & 156.54 mg /g F.W) at the end of storage period. The obtained results are in agreement with the findings of Mohamed (1980) who found that stored grapes showed an increase in sugars content with advanced storage. Results also indicate that there were a significant differences in total sugars content between treatments and the control in the two studied seasons. Furthermore, Ca $(NO_3)_2$ at 2% gave the highest value of total sugars being (161.64 & 158.49 mg /g F.W) as compared with the control treatment which gave the lowest values being (124.00 & 126.78 mg/g F.w) during both seasons . It is well noticed that increasing total sugars of grapes is very important for fruit quality. Increasing total sugars may occurred due to the lack in starch content hydrolyses. These findings were agreement with Rouchaud *et al.*, (1985) they worked on apple Jon Gold cv. stored at 10 °C and found that percentage of fructose increased from 27 % to 41% and glucose from 29% to32% with storage.

It is clear from Tables (15 & 16) that $Ca(No_3)_2$ treatment at the end of storage period (165 days) gave the highest content of total sugars (175.16 & 167.40 mg/g F.W) in the first and second seasons respectively.

Table (13): Effect of calcium and zinc treatments on Total sugars (mg/g F.W) of "Crimson Seedless" grapes during cold storage at 0°C (2002 seasons).

Storage period in days (P) / Treatment (T)	0	15	30	45	60	75	90	105	120	135	150	165	means
Control	100.60	103 46	107 43	115 40	119 23	123 40	128 75	133 40	136 33	138 46	140.10	141.40	124.00
CaCl 2 1%	130 65	134 70	139 5	142 40	145 46	149 60	153 75	157 83	160 08	163 46	165 30	166.50	150.77
$Ca(No_3)_2$ 2%	140.51	144 23	149 53	154 65	158 70	163 70	166 60	169 73	170 20	172 40	174 23	175 16	161.64
Ca-Edeta 1%	120.83	123.30	127 40	134 53	138 68	142 58	147 25	152 35	155 50	157 30	159 13	160.60	143.26
$ZnSO_4$ 0.4%	110.44	115 56	119 50	124 53	128 66	137 63	142 56	146 6	150 60	153.53	155.03	156.06	136.74
Mean	120 67	124 25	128 67	134 3	138 15	143 38	147 78	151 98	154 58	157 03	158 76	159.92	

L.S.D at 5% for T 5.741 P 7.225 T x P 8.23

Table (14): Effect of calcium and zinc treatments on Total sugars (mg/g F.W) of "Crimson Seedless" grapes during cold storage at 0°C (2003seasons).

Storage period in days (P) / Treatment (T)	0	15	30	45	60	75	90	105	120	135	150	165	Mean
Control	110 6	113 56	116 7	119 33	123 45	126 6	130 6	133 53	135 5	136 14	137 26	138 11	126 78
CaCl 2 1%	135 63	138 76	143 36	138 53	142 48	146 43	150 2	153 3	156 53	158 3	164 26	161 16	149 08
$Ca(No_3)_2$ 2%	145 71	148 76	152 65	154 2	155 11	156 7	159 4	162 26	164 33	166 2	167 4	167.1	158 49
Ca-Edeta 1%	125 51	127 48	133 68	136 66	139 6	143 65	147 58	151 21	154 53	156 23	158 23	159 2	144 46
$ZnSO_4$ 0.4%	115 36	119 23	122 4	126 8	130 26	134 23	137 23	142 53	147 66	153 48	156 18	157 15	136 86
Mean	126 56	129 56	133 76	135 06	138 18	141 52	145	148 57	151 71	154 47	156 67	156 54	

L.S.D at 0.05 for T 6.28 P 7.051 T x P 7.66

2-4 Anthocyanin content

As shown in Tables (15 & 16) all treatments (Ca $(NO_3)_2$ & $CaCl_2$ & Ca-Edeta and $ZnSO_4$) had positively influenced with the increment in anthocyanin content as compared with the control in both seasons. At the end of storage, the best treatment which showed the highest value of anthocyanin was $Ca(NO_3)_2$ at 2% (1.850 & 2.060 mg/gF.W) then followed by $CaCl_2$ (1.760 & 1.930 mg/g F.W) Ca-Edeta (1.640 & 1.840 mg/gf.w) and $ZnSO_4$ (1.560 & 1.770mg/g F.W) in descending order as compared with the control which gave the lowest values (1.210 & 1.290 mg/g F.W) in the first and second season, respectively.

Table (15): Effect of calcium and zinc treatments on anthocyanin (mg/g F.W of "Crimson Seedless" grapes. during cold storage at 0°C (2002 seasons).

Storage period in days (P) / Treatment (T)	0	15	30	45	60	75	90	105	120	135	150	165	Mean
Control	0.86	0.89	0.94	1.00	1.08	1.14	1.22	1.30	1.39	1.48	1.57	1.67	1.21
CaCl2 1%	1.26	1.31	1.38	1.47	1.58	1.67	1.80	1.91	2.00	2.10	2.22	2.36	1.76
$Ca(No_3)_2$ 2%	1.32	1.37	1.43	1.53	1.62	1.75	1.87	1.99	2.12	2.26	2.37	2.52	1.85
Ca-Edeta 1%	1.19	1.23	1.28	1.34	1.42	1.51	1.63	1.75	1.89	2.04	2.15	2.27	1.64
$ZnSO_4$ 0.4%	1.10	1.15	1.21	1.29	1.37	1.46	1.57	1.69	1.78	1.89	2.07	2.18	1.56
Mean	1.15	1.19	1.25	1.33	1.41	1.51	1.62	1.73	1.84	1.95	2.08	2.20	

L.S.D at 0.05 for T 0.131 P 0.142 T x P 0.155

Table (16): Effect of calcium and zinc treatments on anthocyanin (mg/g F.W) of "Crimson Seedless" grapes during cold storage at 0°C (2003 seasons).

Storage period in days (P) / Treatment (T)	0	15	30	45	60	75	90	105	120	135	150	165	Mean
Control	0.96	1.01	1.06	1.12	1.19	1.25	1.32	1.4	1.47	1.55	1.46	1.74	1.29
CaCl2 1%	1.45	1.51	1.57	1.64	1.72	1.79	1.88	2.04	2.17	2.28	2.43	2.62	1.93
$Ca(No_3)_2$ 2%	1.58	1.63	1.69	1.76	1.84	1.93	2.03	2.15	2.29	2.45	2.59	2.79	2.06
Ca-Edeta 1%	1.36	1.42	1.49	1.55	1.63	1.72	1.82	1.94	2.07	2.21	2.35	2.5	1.84
$ZnSO_4$ 0.4%	1.29	1.35	1.42	1.49	1.57	1.66	1.76	1.87	1.99	2.12	2.26	2.41	1.77
Mean	1.33	1.38	1.45	1.51	1.59	1.67	1.76	1.88	2.00	2.12	2.22	2.41	

L.S.D at 5% for T 0.147 P 0.151 T x P 0.159

Therefore, there is a direct correlation between Ca and Zn uptake and the increase in sugars content and subsequently anthocyanin synthesis which may be interpret consequently the increase in anthocyanin. So anthocyanin pigment in grape is one of the available few parameters for evaluating grape quality of Crimson Seedless grape cv.

In addition, the highest concentration of (2.52 & 2.79 mg/g. F.W) of anthocyanin pigments was noticed due to $Ca(No_3)_2$ treatment at the end of storage period i.e. after 165 days of cold storage during both season of the experiment respectively.

3-3 Shelf life

Pre-harvest applications of calcium treatments ($CaCl_2$ & $Ca(NO_3)_2$ and Ca-Edeta) gave the high ability for marketing for (6-9 days), while zinc treatment ($ZnSO_4$) reached marketable for 5 days as compared with the control which had ability for marketing for only 2 days at room temperature after storage period (as shelf life).

Berger, *et al.*, (1990) found that grapes stored at 0 °c and 85% RH for 35 days had ability marketing for 3 days at room temperature. Thus it could be concluded that $Ca(NO_3)_2$ was the best treatment in prolonging storage period, as it produced the highest fruit quality and good physical and chemical characteristics during cold storage as compared with the control, beside all treatments gave the highest shelf life.

Moreover, Lima *et al.*, (2000) reported that 1.5% CaCl2 on grape cv. Italia had prolonged storage life of the grapes 56 days. Also, Waskar *et al.*, (1994) found that Thompson seedless grapes treated with 0.6% $CaCl_2$ had long shelf life of fruits.

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تأثير معاملات ما قبل الحصاد على تحسين الجودة والقدرة التخزينية لثمار العنب الكريمسون اللابذرى

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درس تأثير الرش قبل الحصاد بشهر بـ ١% كلوريد الكالسيوم ، ٢% نترات الكالسيوم ، ١%الكالسيوم المخلبي و ٠,٤% كبريتات الزنك خلال موسمي (٢٠٠٢ ، ٢٠٠٣) على تحسين صفات الجودة وزيادة القدرة التخزينية لعناقيد العنب الكريمسون اللابذرى بعد الحصاد أثناء التخزين المبرد على درجه حرارة الصفر المئوي ورطوبة نسبية ٩٠ – ٩٥ %، وقد تم الفحص للعناقيد أثناء التخزين كل أسبوعين طوال فترة التخزين لدراسة الصفات الطبيعية و الكيمائية وكذلك القدرة التخزينية لعناقيد العنب المخزنة وقد أثبتت النتائج المتحصل عليها زيادة في القدرة التخزينية للعناقيد المعاملة عن تلك غير المعاملة حيث زادت مدة التخزين إلى ١٦٥ يوم عند المعاملة بنترات الكالسيوم و ١٥٠ يوم عند المعاملة بكلوريد الكالسيوم والكالسيوم المخلبي وكذلك كبريتات الزنك بينما لم تتعدى ١٢٠ يوم للعناقيد غير المعاملة.

كذلك أظهرت النتائج إن المعاملة بهذه المواد قللت من الفقد فى الوزن ونسبه التالف والحموضة بينما أدت إلى زيادة كل من الصلابة و قوة الشد و نسبة المواد الصلبة الذائبة والسكريات الكلية ومحتوى الانثوسيانينات وكذلك طول فترة العرض للعناقيد بعد فترات التخزين المبرد.

ومن هنا يتضح أن أفضل الصفات الثمريه خلال وبعد انتهاء فتره التخزين كانت لعناقيد عنب الكريمسون اللابذرى المعاملة بنترات الكالسيوم بتركيز ٢%