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Use Pre-Harvest Treatments To Keeping Quality and Long Shelf Life of Some Date Palm Cultivars

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Abstract

This study was carried out on three date palm cultivars (Samany, Amhat and Sewy) grown in Abo-Rawash area Giza Governorate, Egypt. This work aimed to study the influence of pre-harvest treatments as direct spray on fruits by solutions boron (0.5% in the form of boric acid) and calcium (10 g/L (w/v) in the form of calcium nitrate) alone or in combination to improve quality of date palm fruits during cold storage and increasing marketing period (Shelf life). Fruits were picked in maturity stage and stored at 0.0 ± 1° C and 85 – 90% relative humidity (RH). Fruit quality characteristics i.e. weight loss, decay %, fruit firmness (Lb\inch^2), total soluble solid percentage (TSS %), total acidity percentage (TA %), total soluble sugars and tannins % were evaluated. Assay of the stored fruits was made at 20 days intervals and additional fruits were left at room temperature (20± 2° C) for one week as stimulated marketing period. The results showed that all spraying treatments gave the best effect in fruit quality assessments when compared with control. The combined treatment gave the highest value of fruit TSS% and total soluble sugars while decreasing TA% weight loss % and fruit decay % during cold storage for 40 days. Furthermore, the same trend was observed after cold storage for week on 20± 2° C. It can be recommended spraying date palm fruits twice with the combined treatment of 0.5% boric acid + 10 g/L (w/v) calcium nitrate to improve fruit quality during cold storage and shelf life period.

Key Words: *Date palm, Pre-harvest, Calcium nitrate, boric acid, Storage, Fruit quality.*

Hasat Öncesi Denemelerle Bazı Hurma Ağacı Kültür Bitkilerinin Kalitesinin Korunmasıve Raf Ömrünün Uzatılması

Özet

Bu çalışma; Mısır Giza eyaleti Abo-Rawash bölgesinde yetiştirilen 3 hurma ağacı kültür bitkisi (Samany, Amhat ve Sewy) üzerinde gerçekleştirilmiştir. Bu çalışmada hurma ağacı meyvelerinin soğuk depolama boyunca kalitesini yükseltmek ve raf ömrünü uzatmak için, meyvelerin üzerine tek yahut kombine olarak bor (%0,5 borik asit formunda) ve kalsiyum (10 g/L kalsiyum nitrat formunda) çözeltileri püskürtmek gibi hasat öncesi denemelerin etkisinin araştırılması amaçlanmıştır. Meyveler olgunluk devresinde seçilmiş ve 0.0 ± 1°C ve % 85-90 bağıl nemde depolanmıştır. Ağırlık kaybı, % çürüklük, meyve sertliği (Lb/inch^2), % toplam çözünür katı madde (% TSS), % toplam asitlik (% TA), toplam çözünür şeker ve % tannins gibi meyvenin kalite özellikleri belirlenmiştir. Depolanmış meyvelerin analizleri 20 günlük aralıklarla yapılmış ve ilave meyveleri oda sıcaklığında (20±2°C) 1 hafta raf ömrü için bırakılmıştır. Bütün püskürtme denemelerinin, kontrol örnekleri ile karşılaştırıldığında meyvenin kalite özellikleri üzerine en iyi etkiyi verdiği belirlenmiştir. 40 günlük soğuk depolama boyunca, kombine denemelere maruz bırakılan meyvelerin % TSS ve toplam çözünür şeker miktarları en yüksek değeri verirken, % TA, % ağırlık kaybı ve % meyve çürüklüğünün düştüğü belirlenmiştir. Bununla beraber, aynı eğilim soğuk depolamadan sonra 20 ±2°C de, 1 hafta gözlenmiştir. Meyvelerin soğuk depolama boyunca kalitesini ve raf ömrünü arttırmak için hurma ağacı meyvelerinin hasat öncesi 2 kez % 0,5 borik asit+ 10 g/L kalsiyum nitrat çözeltileri ile kombine olarak spreylenmesi önerilebilir.

Anahtar Kelimeler: *Hurma ağacı, Hasatöncesi, Kalsiyum nitrat, Borik asit, Depolama, Meyve kalitesi.*

Introduction

Date palm (*Phoenix dactylifera* L.) is the most successful and important subsistence crop in most of the hot arid desert regions (Botes and Zaid, 1999). Generally, whole date are harvested and marketed at three stages of development: Mature firm (Bisir or Khalal), Full ripe (Rutab) and Dry (Tamr). The decision for harvesting at one or other stage depends on cultivar characteristics, especially soluble tannins levels, climatic conditions and market demand (Glasner et al., 1999). The optimum temperature degree to storage dates fruits from zero – 4^{0}C (Al-Redhaiman, 2005) and relative humidity (RH) from 75 – 90 % to keeping for month or more by different varieties.

Boron is an essential micronutrient required for optimal yield and fruit quality (Khalifa et al., 2009). It is important in pollen tube growth, successful fruit set and formation of feeder roots. Symptoms of boron deficiency include internal and external core formation in fruits and the development of small-deformed fruits (Donald et al., 1998). Ca is known to stabilize cell membranes and in this way may prevent physio-

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logical disorders attributed to Ca deficiency (Benavides et al., 2002). The effect of calcium as form chloride or nitrite on firmness is likely to be associated with the calcium content of the covalently-bound pectin fraction (Siddiqui and Bangerth, 1995). The calcium used to increase calcium content of fruits and its important role in prolonging shelf-life of fruits and improving fruit quality as well as resistance to pathological disorders (Hafez and Haggag, 2007 and Hafez et al., 2010).

The purpose of this study was to investigate using mineral nutrition pre-harvest application of each boric acid and calcium nitrate alone or in combination on fruit quality assessments during cold storage periods and marketing period.

Materials and Methods

This study was carried out on three date palm cultivars (Samany, Amhat and Sewy) during two successive seasons of 2008 and 2009 grown in a private orchard at Abo-Rawash region, El-Giza Governorate, Egypt. Sixteen uniform date palm trees from each cultivar were chosen randomly as four trees/ treatment. Similar in growth and received common horticulture practices, were selected for this investigation. Mineral nutrition pre-harvest treatments were used as spraying with 0.5 % boric acid, 10 g/L Calcium nitrate (w/v) and mixture of boric acid (0.5%) + calcium nitrate (10 g/L w/v). Date palm trees were sprayed with water as control. In each season, the nutrition treatments were sprayed twice. The first was at the beginning, while the second one after two weeks. Undamaged mature date palm fruits, free from apparent pathogen infection, uniform in shape, weight and color picked separately from each treated per cultivar. Fruits were harvested at the 2nd mid of September during each studying seasons. Then, fruits transported to the laboratory of Agriculture Development System (ADS) project, faculty of Agric., Cairo Univ., Egypt. The selected fruits were washed with tap water; air dried and then packed in perforated carton boxes in three replicates for each treatment (1.5 kg/replicate). Each treatment packed in six boxes; it's classified into two groups. The 1st group (3 boxes) contain fruits for periodical determination the physical properties. The other contained fruits were used for determination of chemical properties. Fruits stored at 0 ± 1° C with relative humidity (RH) 85-90% for 40 days. Assay of the stored fruits was made at 20 days intervals. A sample of 30 fruits of each replicate per treatment from each cultivar were taken out at the end of cold storage period and left at room temperature (20 ± 2°C) for one week, then examined for decay percent.

Fruit Quality Assessments

I- Physical Properties Including

Decay Percentage: percentage of fruits decay was calculated in relation to the initial weight of stored fruits. At every storing date, rotted date fruits removed and weighted. Also, the percentage of fruit decay was calculated in marketing period.

Weight Loss Percentage: Date fruits were periodically weighted and the losses were recorded for each replicate. Data of weight loss were calculated as percentage from the initial weight.

Fruit Firmness (Lb\inch^2): fruit firmness was determined as Lb/inch^2 by using fruit pressure tester mod. FT 327 (3-27 Lbs).

2- Chemical Properties

Total Soluble Solids Percentage (TSS %): was determined in date palm fruit juice using a hand refractometer.

Total Acidity (TA %): was estimated as g citric acid and malic acid /100 ml juice according to (A.O.A.C., 1995).

Total Sugars (g/100 g "fresh weight" Fw): were determined in stored date fruits by method described by (Smith et al., 1956).

Fruit Tannins content: was determined by method described by (A.O.A.C., 1995).

The data were subjected to analysis of variance and the method of Duncan was used to differentiate means at 0.5 % level (Duncan, 1955).

Results and Discussion

I- Physical Properties

Fruit Decay Percentage

Table 1 shows that fruit decay percentage was gradually increased as a function of cold storage period at 0 ± 1° C up to 40 days either treated or control fruits of all date palm fruits under study in the first season. Meanwhile, all treatments were effective in reducing the rate of decay % compared to the control but the effect was more pronounced with boric acid (0.5%) + Ca $(NO_3)_2$ 10 g/L treatments followed by Ca $(NO_3)_2$ as compared with boric acid treatments of Samany, Amhat and Sewy date palm fruits. However, after 40 days storage untreated fruit (control) lost 66.50, 18.20 and 18.20 for fruit Samany, Amhat and Sewy, respectively in the first season. In addition, after 40 days storage spraying date palm fruits with boric acid + Ca $(NO_3)_2$ treatments were the best followed by Ca $(NO_3)_2$ then boric acid as compared with the control in a descending order in the first season. However, results in the second season behaved the same as that of the first season. Generally, it could be noticed that all treatments were effective in reducing the rate of fruit decay at any time of storage and consequently increased storage life than that of the control. Meanwhile, the lowest fruit decay percentage with obtained with boric acid + Ca $(NO_3)_2$ and Ca $(NO_3)_2$ treatments. Also, the

highest fruit decay was recorded for untreated fruits during the two seasons.

These results are in particular agreement with the finding (Brackmann et al, .2000) on apple. Who found of cold storage is required to reduce this generation of heat and fruit decay.

Shelf Life

Data showed that the effect of pre-harvest with nutrition treatments on fruit decay percentage of 3 date palm stored for 40 days at 0 ± 1° C and kept at 20 ± 2° C in normal atmosphere for one week figures 1-3. It is clear that the fruit decay (%) in Samany cultivar figure 1 were (55.83 & 55.6), (50.8 & 51.4), (44.9 & 45.2) and (39.0 & 38.7) %. While, Amhat cv. figure 2 were (37.83 & 38.4), (32.0 & 32.0), 31.0 & 31.3) and (31.4 & 31.0) %. As for the Sewy cv. figure 3 the fruit decay (%) were (43.2 & 44.0), (28.6 & 29.3), (24.6 & 25.2) and (21.7 & 22.4) % at control treatment, boric acid, Calcium nitrate and in combination, consecutively were made in the two seasons. It is obvious that the best shelf-life was obtained with combination of boric acid + Calcium nitrate treatment in all date cultivars.

From results, it is clear that boric acid and calcium nitrate treatments may be play an important role in reduced fruit disorders. Mean while, the cell wall proportion of the mycelia increased on a dry weight basis due to an increase in uronic acid, Ca, P, Na and neutral sugar contents of the cell well with increasing $Ca(NO_3)_2$ in the media. The resulting thickening of the fungal cell wall caused by calcium ion may be an important factor in the host-pathogen relationship (Chardonnet et al., 1997).

Weight loss percentage

Data illustrated in Figures 4-6 indicated that fruit weight loss is directly proportional and coincided with the increase of storage duration in all spraying treatment under study of three date palm fruits. After 20 days storage, spraying with boric acid and Ca $(NO_3)_2$ were better than boric acid + Ca $(NO_3)_2$ treatments with significantly differences in the first season of the three date palm fruits. Meanwhile, after 40 days storage, boric acid + Ca $(NO_3)_2$ treatment was better than boric acid or Ca $(NO_3)_2$ with significant differences. The same trend of results was also found in the second season. Generally, all treatments were effective in reducing the rate of weight loss percentage compared to the control. The lowest fruit weight loss (%) was obtained with boric acid + Ca $(NO_3)_2$ treatments. Meanwhile, the highest fruit weight loss percentage was recorded for untreated fruits.

These results confirm the finding of (Daood, 1995) on Zaghloul dates; He demonstrated that the physiological weight loss was generally lower in $CaCl_2$ treated fruits.

Fruit Firmness (Lb/inch^2)

Fruit firmness of 3 dates palm affected by the pre-harvest nutrition treatments during 2008 and 2009 seasons are listed in Table 2. Results showed that the means of fruit firmness for all date cultivars in this study gradually decreased by storage periods advanced in fruits treated on untreated Table 2. Also, it can be noticed from data obtained that all tested treatments have the significant height effects on firmness comparing with the control, in the two seasons. The fruit firmness were 13.2 to 17.3 Lb/inch2 during 2008 season and 12.7 to 17.8 Lb/inch^2 in 2009 season comparing with 12.0 to 17.0 Lb/inch^2 and 12.11 to 17.3 Lb/inch^2 in control treatment, respectively within the storage periods concerning Samany cultivar. While, the fruit firmness in Sewy cultivar were 10.2 to 40 Lb/inch^2 in the 1st season and 11.3 to 43.0 Lb/inch^2 in the 2nd season compare with the control 9.8 to 33.3 Lb/inch^2 and 10.1 to 33.5 Lb/inch^2, respectively within the storage days. As for Amhat cultivar, the fruit firmness were 16.2 to 17.43 Lb/inch^2 in the first season and 16.0 to 17.9 Lb/inch^2 in the second season as compare with control treatment 15.4 to 16.7 Lb/inch^2 and 15.0 to 16.8 Lb/inch^2 respectively within storage periods. A combined treatment of B + Ca was significantly increased the fruit firmness comparing with the control fruits and gave the highest fruit firmness in both studied seasons when compare with the other treatments. Meanwhile, treatments with boron or calcium only gave the same effect in reducing the rate of fruit softening without significant differences between them. On the other side, the untreated fruits were softening in all periods of storage in both investigated seasons. These results were noticed in all cultivars in this study.

These results might be due to the positive effect of applying boron and calcium alone or in combination on treated fruits. The obtained results could be explained by statement of (Wojcik et al., 1999). This showed that B application increased apple Ca Concentration and decreased fruit bitter pit, internal breakdown and Gloeosporiun-rot.

The favorable effect of calcium obtained by (Siddiqui and Bangerth, 1995) on Golden Delicious apples, it suggested that the observed effects of $CaCl_2$ on fruits firmness are likely to be associated with the calcium content of the covalently-bond pectin fractions. Also (Benavides et al., 2002) found on Golden smoothee that the fruit firmness increased when calcium was applied. As well as (Montanro et al., 2006) on kiwifruit suggests that transpiration is not the only factor controlling Ca transport, and light also influenced the Ca concentration in xylem sap. Taking into account that auxin is able to stimulate Ca uptake and light promotes the biosynthesis of auxin protecting phenols (hydroxycinnamic acid). So, a new working hypothsis is proposed that: light induces the biosynthesis of such

phenols, which in directly decreases auxin degradation, and these fore increases Ca accumulation.

Table 1. Effect of boric acid and calcium nitrate spraying on fruit decay percentage of 3 date palm fruits stored at 0°C for 40 days in 2008 and 2009 seasons.

Characters	Fruit decay percentage (%)					
Cultivars	Samany					
Treatments	Periods of storage (in days)					
	0.0		20		40	
	2008	2009	2008	2009	2008	2009
Control	0.00	0.00	56.00a	57.20a	65.90a	66.50a
Boric acid (0.5%)	0.00	0.00	49.30b	50.30b	63.30b	64.20b
$Ca(NO_3)_2$ (10g/l)	0.00	0.00	42.32d	43.00d	51.64d	52.40d
Boric acid + $Ca(NO_3)_2$	0.00	0.00	44.63c	45.80c	60.23c	62.30c
Cultivars	Sewy					
Control	0.00	0.00	6.00b	6.60b	19.30a	18.20a
Boric acid (0.5%)	0.00	0.00	3.20d	3.90d	16.76b	17.60b
$Ca(NO_3)_2$ (10g/l)	0.00	0.00	5.30c	5.60c	13.90c	14.60c
Boric acid + $Ca(NO_3)_2$	0.00	0.00	10.63a	11.70a	11.32d	12.90d
Cultivars	Amhat					
Control	0.00	0.00	6.30b	6.60b	17.30a	18.20a
Boric acid (0.5%)	0.00	0.00	3.60d	3.90d	16.67b	17.60b
$Ca(NO_3)_2$ (10g/l)	0.00	0.00	5.30c	5.60c	13.67c	14.70c
Boric acid + $Ca(NO_3)_2$	0.00	0.00	10.92a	11.20a	11.92d	12.90d

Means followed by the same letter (s) within each column aren't significantly different at 5% level.

Table 2. Effect of boric acid and calcium nitrate spraying on firmness (Lb/inch^2) of 3 date palm fruits stored at 0°C for 40 days in 2008 and 2009 seasons.

Characters	Fruit firmness (Lb/inch^2)					
Cultivars	Samany					
Treatments	Periods of storage (in days)					
	0.0		20		40	
	2008	2009	2008	2009	2008	2009
Control	17.0	17.3	16.1b	16.2b	12.0b	12.1a
Boric acid (0.5%)	17.1	17.4	17.0a	17.2a	13.3a	13.4a
$Ca(NO_3)_2$ (10g/l)	17.3	17.8	16.9a	17.1a	13.2a	12.7a
Boric acid + $Ca(NO_3)_2$	17.1	17.6	17.1a	17.0a	13.8a	13.0a
Cultivars	Sewy					
Control	33.3b	33.3d	28.5d	28.3d	9.8d	10.1c
Boric acid (0.5%)	40.0a	42.0c	30.6b	30.8c	10.2c	12.4a
$Ca(NO_3)_2$ (10g/l)	40.0a	43.0a	31.4a	35.4b	10.7b	11.3b
Boric acid + $Ca(NO_3)_2$	40.0a	42.5b	29.5c	36.7a	11.5a	12.7a
Cultivars	Amhat					
Control	16.7b	16.8b	15.6a	15.9a	15.4c	15.0c
Boric acid (0.5%)	17.1a	17.7a	16.9a	16.9a	16.2b	16.0b
$Ca(NO_3)_2$ (10g/l)	17.4a	17.9a	17.0a	17.1a	16.5ab	16.7a
Boric acid + $Ca(NO_3)_2$	17.3a	17.6a	16.8a	17.0a	16.6a	16.8a

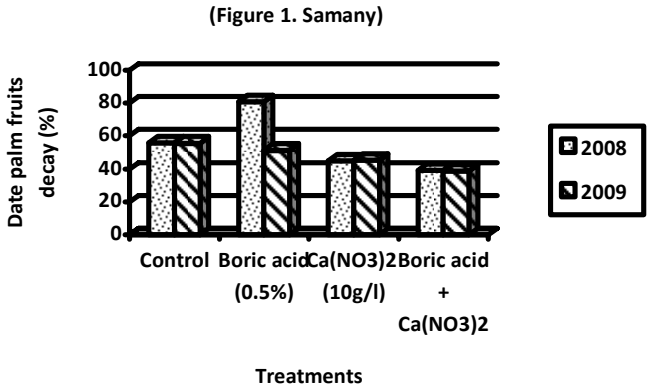
Means followed by the same letter (s) within each column aren't significantly different at 5% level.

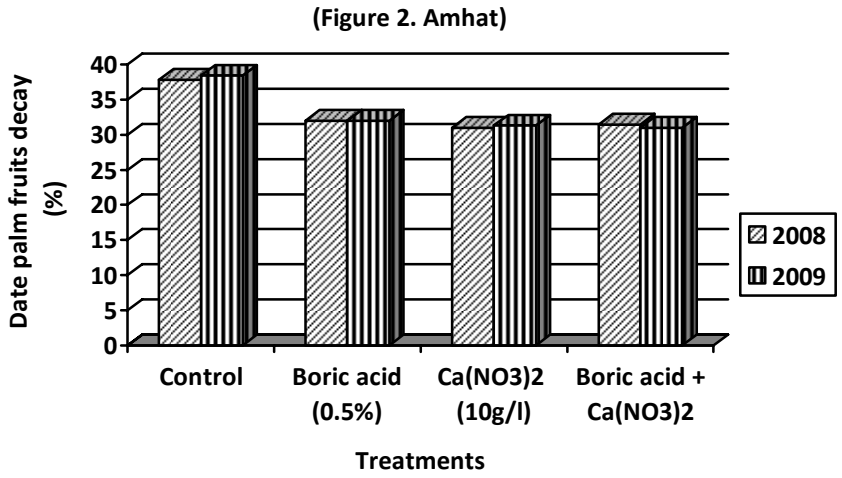
I- Chemical Properties

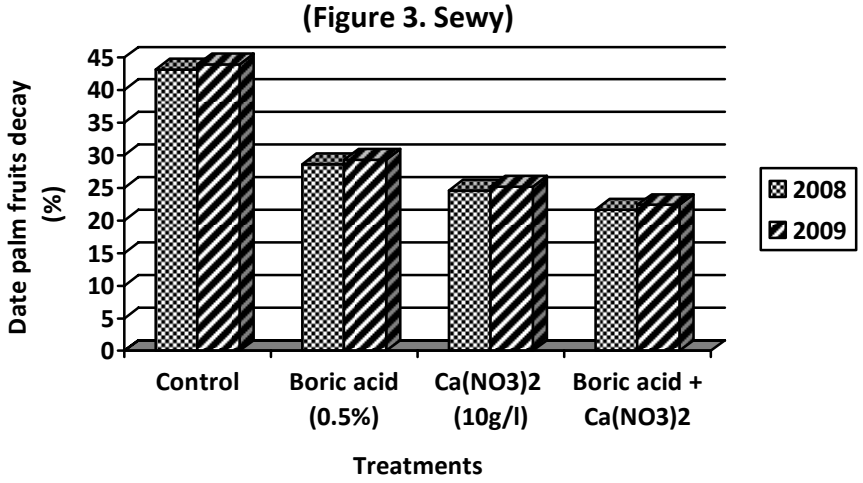
Total Soluble Solids (TSS %)

Results in Table 3 show the effect of boric acid and calcium sprays on total soluble solids percentage of some date palm fruits stored at 0 ± 1° C and 85-90 % RH. It is clear that total soluble solids percentage of all treatments used increased with prolonging period of fruit storage in the first season. However, Sewy fruits proved to be the richest cultivar regarding its content of TSS throughout the storage period. The

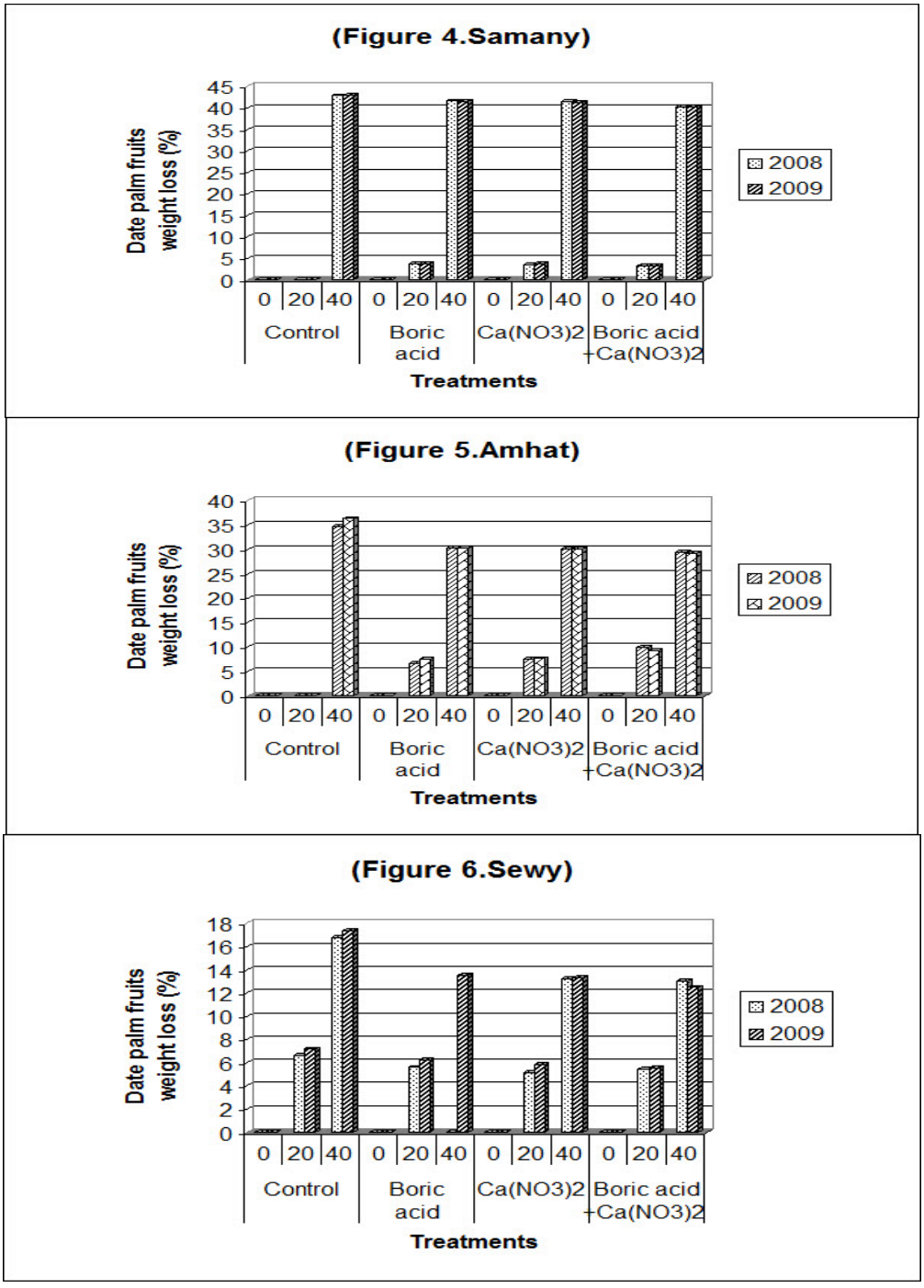
reverse was true with Samany CV. Meanwhile, Amhat cv. showed intermediate position in this respect.







Figures 1-3. Effect of pre-harvest sprays of boric acid and calcium nitrate alone or combination on 3 date palm fruits decay (%) in marketing period in 2008 and 2009 seasons.



Figures 4-6. Effect of pre-harvest sprays of boric acid and calcium nitrate alone or combination on 3 date palm fruits weight loss (%) during cold storage periods in 2008 and 2009 seasons.

As for the effect of fruit treatment with boric acid and calcium sprays on fruit TSS content, it is quite evident that all combination of Samany cv. particularly the control recorded the highest values of fruit TSS % on the reverse, all combinations of Amhat particularly recorded the lowest values of fruit TSS % fruit total soluble solids content in the second season took nearly the same trend in the first one. The gradual increase of total soluble solids with the increase of storage temperature and the progress of storage period could be due to the degradation of complex in soluble compounds like starch to simple soluble compounds like sugars which are the major component of soluble solids content in the fruits. Besides, such changes increased with the increase in storage temperature hence the temperature plays an important role as a catalytic

factor. Moreover, the changes increased with the progress of storage period, where it allowed the accumulation of soluble solids in fruits. The obtained data are similar of those obtained by (Cohen et a., 1991) on citrus and (Brachmann et al., 1999) on Valencia orange. They mentioned that total soluble was increased during storage.

Table 3. Effect of boric acid and calcium nitrate spraying on total soluble solids percentage of 3 date palm fruits stored at 0°C for 40 days in 2008 and 2009 seasons.

Characters	Total soluble solids percentage (%)					
Cultivars	Samany					
Treatments	Periods of storage (in days)					
	0.0		20		40	
	2008	2009	2008	2009	2008	2009
Control	21.67c	22.00c	26.32a	27.70a	23.10d	22.90d
Boric acid (0.5%)	21.00c	22.70c	25.00a	27.20b	28.10b	27.10b
$Ca(NO_3)_2$ (10g/l)	23.67c	24.50b	25.10a	27.10b	25.67c	25.60c
Boric acid + $Ca(NO_3)_2$	30.67a	31.40a	25.10a	27.10b	28.61a	27.60a
Cultivars	Sewy					
Control	30.67c	31.20c	28.50c	29.50c	32.67b	33.30b
Boric acid (0.5%)	30.31c	31.40c	29.36b	30.60b	40.67a	40.00a
$Ca(NO_3)_2$ (10g/l)	31.67a	32.70a	30.63a	31.40a	41.00a	40.00a
Boric acid + $Ca(NO_3)_2$	31.00b	32.00b	27.60d	28.50d	40.89a	40.00a
Cultivars	Amhat					
Control	30.67a	31.80a	27.00a	27.20c	30.00b	29.40b
Boric acid (0.5%)	28.67b	29.50b	32.00a	32.20a	28.66c	27.06c
$Ca(NO_3)_2$ (10g/l)	27.30c	28.40c	27.30c	27.50c	33.21a	32.90a
Boric acid + $Ca(NO_3)_2$	24.39d	25.70d	29.10b	29.40b	23.50d	22.50d

Means followed by the same letter (s) within each column aren't significantly different at 5% level.

Table 4. Effect of boric acid and calcium nitrate spraying on total acidity percentage of 3 date palm fruits stored at 0°C for 40 days in 2008 and 2009 seasons.

Characters	Total acidity percentage (%)					
Cultivars	Samany					
Treatments	Periods of storage (in days)					
	0.0		20		40	
	2008	2009	2008	2009	2008	2009
Control	0.35a	0.30a	0.30a	0.35a	0.36a	0.35a
Boric acid (0.5%)	0.25b	0.20b	0.31a	0.31a	0.30ab	0.31ab
$Ca(NO_3)_2$ (10g/l)	0.32ab	0.27ab	0.30a	0.31a	0.30ab	0.35a
Boric acid + $Ca(NO_3)_2$	0.36a	0.31a	0.30a	0.32a	0.26c	0.25ab
Cultivars	Sewy					
Control	0.47b	0.45b	0.40a	0.38a	0.63a	0.60a
Boric acid (0.5%)	0.57a	0.55a	0.37ab	0.35ab	0.50ab	0.57ab
$Ca(NO_3)_2$ (10g/l)	0.58a	0.55a	0.34b	0.32b	0.50ab	0.52b
Boric acid + $Ca(NO_3)_2$	0.46b	0.45b	0.37ab	0.35ab	0.43c	0.32c
Cultivars	Amhat					
Control	0.63a	0.65a	0.40b	0.41b	0.60a	0.61a
Boric acid (0.5%)	0.52b	0.55b	0.34c	0.35c	0.60a	0.60a
$Ca(NO_3)_2$ (10g/l)	0.60ab	0.60ab	0.34c	0.35c	0.62a	0.60a
Boric acid + $Ca(NO_3)_2$	0.40c	0.45c	0.46a	0.45a	0.43b	0.40b

Means followed by the same letter (s) within each column aren't significantly different at 5% level.

Fruit Acidity (%)

Concerning the effect of cultivars on fruit acidity, Table 4 shows that Amhat fruits gave the richest fruit during the 40 days of storage in the first season. Besides Samany fruits recorded the lowest values of acidity after 40 days storage period. Sewy cv. took intermediate position in this respect. As for the effect of fruit treatment with boric acid, Ca $(NO_3)_2$ and boric

acid + Ca $(NO_3)_2$ on fruit acidities, it is clear that boric acid + Ca $(NO_3)_2$ treatment succeeded in reducing fruit acidity during 40 days of storage as compared with untreated ones "control". However, the differences between the two tested boric acid and Ca $(NO_3)_2$ treatments were lacking from statistical stand point in the first season. The results of the second season as it appear from Table 4 were more or less similar to that of the first one.

Table 5. Effect of boric acid and calcium nitrate spraying on total sugars percentage of 3 date palm fruits stored at 0°C for 40 days in 2008 and 2009 seasons.

Characters	Total sugars percentage (%)					
Cultivars	Samany					
Treatments	Periods of storage (in days)					
	0.0		20		40	
	2008	2009	2008	2009	2008	2009
Control	20.00c	20.30b	21.03b	22.21a	22.53c	22.60c
Boric acid (0.5%)	20.40b	20.39b	21.00a	22.19a	22.90a	22.98b
$Ca(NO_3)_2$ (10g/l)	20.40b	20.44a	22.67a	21.65b	22.93a	23.21a
Boric acid + $Ca(NO_3)_2$	20.69a	20.54a	22.33a	21.96b	22.67c	22.96c
Cultivars	Sewy					
Control	20.33d	20.96d	23.67b	23.65b	24.00b	24.24b
Boric acid (0.5%)	21.23c	21.14c	23.30a	23.42c	24.60a	24.63a
$Ca(NO_3)_2$ (10g/l)	21.67b	21.63b	23.60b	23.63b	24.67a	24.69a
Boric acid + $Ca(NO_3)_2$	22.00a	21.76a	24.00a	23.89a	24.63a	24.69a
Cultivars	Amhat					
Control	21.66b	21.37b	22.83a	22.65a	23.67b	23.69b
Boric acid (0.5%)	21.43c	21.53c	22.67a	22.51a	23.00c	23.33c
$Ca(NO_3)_2$ (10g/l)	21.65a	21.70b	22.30b	22.34b	23.69b	23.81b
Boric acid + $Ca(NO_3)_2$	22.00a	21.90a	22.00b	22.46b	24.00a	23.96a

Means followed by the same letter (s) within each column aren't significantly different at 5% level.

Table 6. Effect of boric acid and calcium nitrate spraying on tannins percentage of 3 date palm fruits stored at 0°C for 40 days in 2008 and 2009 seasons.

Characters	Tannins percentage (%)					
Cultivars	Samany					
Treatments	Periods of storage (in days)					
	0.0		20		40	
	2008	2009	2008	2009	2008	2009
Control	16.00a	16.20a	15.67a	15.80a	13.49a	13.67a
Boric acid (0.5%)	16.13a	15.96a	15.40a	15.36a	13.64a	13.36a
$Ca(NO_3)_2$ (10g/l)	16.30a	16.20a	15.60a	15.67a	13.73a	13.60a
Boric acid + $Ca(NO_3)_2$	16.31a	16.60a	15.67a	15.67a	13.69a	13.67a
Cultivars	Sewy					
Control	16.00a	16.13a	14.67a	14.79a	14.00a	14.20a
Boric acid (0.5%)	16.67a	16.54a	14.67a	15.20a	14.30a	14.01a
$Ca(NO_3)_2$ (10g/l)	16.30a	16.13a	14.90a	15.13a	14.21a	14.66a
Boric acid + $Ca(NO_3)_2$	16.30a	16.37a	14.67a	15.28a	14.13a	14.07a
Cultivars	Amhat					
Control	16.00a	16.02a	14.67a	14.79a	14.30a	14.30a
Boric acid (0.5%)	16.30a	16.17a	14.70a	14.67a	14.36a	14.30a
$Ca(NO_3)_2$ (10g/l)	16.13a	16.00a	14.67a	14.89a	14.43a	14.31a
Boric acid + $Ca(NO_3)_2$	16.30a	16.17a	14.67a	14.79a	14.36a	14.30a

Means followed by the same letter (s) within each column aren't significantly different at 5% level.

The decrease in total acidity (citric and malic acids) during storage at different treatments could be due to its consumption in respiratory activities with the progress of storage time and the increase in storage temperature, as citric and malic acid could be used as organic substrate in the respiration process.

The results of storage temperature and related discussion go in line with those reported by (Du, 1997) on plum and (Brackmann et a., 1999) on Valencia orange, they mentioned that the percentage of total acidity was slightly decrease as results of storage temperature.

Fruit total Sugars Content

A glance to Table 5 indicate that total sugars content of different treatments increased with increasing the period of storage in both seasons. Meanwhile, Sewy and Amhat fruits contained higher amounts of sugars than the corresponding ones of Samany CV. However, significant differences between boric acid and Ca $(NO_3)_2$ treatments regarding fruit content of total sugars during the storage period in both seasons. In additions, all treatments of Sewy cv. including the control recorded the highest values of fruit total sugars content as compared with the analogous ones of Amhat and Samany CVs.

The results of storage temperature and storage period on sugar constituents confirmed the reports of (Daood, 1995) on dates; he mentioned that total sugars and inverted sugars were increased during storage.

Fruit Tannins Content

It is quite clear from Table 6. that fruit tannins content didn't show any significant response to the cultivar, whether the fruits were treated with boric acid and Ca $(NO_3)_2$ or untreated during storage period 40 days in 2008 and 2009 seasons, respectively at $0 \pm 1^{\circ}$ C and 85-90 % RH in the first and second seasons. Conclusively, fruit tannins content of date fruits decreased with the progress of storage period. Generally, the three studied factors namely cultivars, fruits treatment with boric acid and fruits treatment with Ca $(NO_3)_2$ failed to exert an obvious, remarkable and pronounced effect on fruit tannins content during storage period under cold storage at $0 \pm 1^{\circ}$ C.

The results of storage temperature and storage period in this respect go in line with the finding of (Pillay et al., 2005; Mohamed, 2007 and Mahgoub et al., 2008).

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