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EFFECT OF PRE-HARVEST TREATMENT ON IMPROVING FRUIT QUALITY AND STORAGE ABILITY OF APRICOTS

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ABSTRACT

This study was carried out during the seasons of 2002 and 2003 to evaluate the effect of calcium chloride, GA_3 and carbendazim as preharvest treatments on fruit characteristics at harvest time and their effect on storability of apricot fruit at cold storage .The data revealed that, spraying apricot trees two weeks before harvest with carbendazim at 750 ppm was effective for reducing decay fruit percentage at cold storage and keeping the quality of apricots for one month after harvest . Furthermore, spraying trees with GA_3 at 25 ppm and $CaCl_2$ at 2% enhanced fruit firmness, reduced the percent of decayed fruit and the total weight loss in of apricot fruits. Also, these treatments keept fruit quality and extend marketing period of apricot fruit in Egyptian emporiums .

INTRODUCTION

Apricot is one of the most important fruits planted in Egypt. In this respect, Amar is one of well adapted apricot cultivars, which is widely grown in Egypt for many years. Yet nowadays it produce low yield . Recently, various apricot cultivars have been introduced to Egyptian agriculture as Amal and Canino, which showed great success especially in new reclaimed lands.

The total cultivated area of apricot in Egypt reached about 20909 feddan, with total production about 70424 tons according to the last statistics of the Ministry of Agriculture (2003).

Several investigations were carried out to improve fruit quality to be more acceptable to the consumer, (Autio & Greene, 1994). Thus, no doubt that process of pre , post-harvest and storability for local market and export is as important as fruit production and good yield. As a result of increasing yield of apricot, shortness of it's life and marketing and the loss of fruits during post-harvest system of grading, packing, transportation, storage, post-harvest diseases and marketing. There is a desperate need for studying how to extend the marketing period and reduce the loss in fruits. Therefore, storage of fruits is necessary to supply apricot fruits frequently and for a longer period of time.

The main objective of this investigation was to study the effect of calcium chloride, gibberellic acid and carbendazim which has found to play an important role in maintaining fruit quality and prolonging storage life as a pre-harvest treatment on the keeping quality of Canino apricot fruits under cold storage .

MATERIAL AND METHODS

This study was carried out during the two successive seasones of 2002-2003 on Canino apricot trees to evaluate the effect of calcium chloride, gibberellic acid (GA_3) and carbendazim as pre-harvest treatments on fruit quality at harvest time and storage ability under cold condition and during marketing conditions.

The trees were about six years old , budded on seedly apricot rootstook grown in a sandy soil , planted at 6 m between rows and 5 m between trees (140 trees per feddan) in a private orchard at El-Khatatba , Monofia, Governorate . A factorial experiment in randomized complete block design was used represented with 6 trees per plot and 6 replications per treatment . A single guard tree separated each treatment . Treated rows were separated by 2 non-treated guard tree rows according to (Southwick &Yeager, 1995).

The applied treatments were:

1. Trees sprayed with water .
2. Trees sprayed with$CaCl_2$ at 1% .
3. Trees sprayed with $CaCl_2$ at 2% .
4. Trees sprayed with GA_3 at 25 ppm .
5. Trees sprayed with GA_3 at 50 ppm .
6. Trees sprayed with Carbendazim at 750 ppm .

Triton B at 300 ml /600 L. water was add with each treatment as wetting agent .

These treatments were applied on 13 and 24 May at the first and second seasons respectively.

Fruits were harvest at maturity stage (commercial ripeness) , at 27 May 2002 and at 8 June 2003to reduce bruising and to extend their shelf life , however variations of color and firmness have been reported among different apricot varieties, be in this parameter the best single indicator of fruit ripening . About 60 Kg fruits from each treatment were harvested at early morning and transported to the Pomology Department, Faculty of Agriculture, Mansoura University .

At the beginning , samples from each replicate of each treatment were taken to determine the initial properties . Fruits were sorted to remove any infected and damaged ones . So and , fruits were packed using ventilated plastic bags according to Agar & Plot (1995). All fruits bags were weighted and every six bags were put in ventilated carton box (50x30x12) cm. The total number of boxes were 18 for all treatment , each treatment consists of 3 carton boxes , each box contains 6 ventilation plastic bags and stored at 2°C±1 , at 90-95 % relative humidity according to Souty *et al.* (1995) . One carton box for each treatment was taken at 10 days interval to determine loss in weight , decay percentage and changes in fruit quality during storage .

After each period of cold storage the flowing parameters were determined:

A- Total loss in fruit weight :

1- Loss in fruit weight percentage.

2- Decay percentage .
3- Total loss in fruit weight .
Total loss = % loss in weight + % decayed fruits

B- Fruit quality :

1- Fruit firmness :

It was expressed as $lb.in^{-2}$. (Tzoutzoukou & Bourains, 1997) .

2- Soluble solid content (SSC):

Using a hand refractometer .

3- Total titratable acidity:

It was determined in fruit juice as citric acid according to (A.O.A.C, 1980) .

4- Soluble solid content (SSC) / acid ratio.

5- Changes in fruit pigments:

Weight of 0.5 g fresh material was extracted by 10 ml methanol for 24 hr under laboratory temperature after adding trace amount of sodium bicarbonate , then both chlorophyll and carotenoids were determined by spectrophotometer at wave length 452.5, 650 and 665 nm according to the methods of Mackiny (1941) .

6- Statistical analysis:

The obtained data were analyzed according to the procedure outlined by Gomez and Gomez (1984).Differences among treatment means were compared by using the least significant differences test (LSD) at 5% level of probability.

RESULTS AND DISCUSSION

I - Effect of preharvest treatments on total loss in fruit weight of apricot fruit:

Total loss in weight including both loss in fruit weight due to loss in water and decayed fruit during postharvest and storage conditions which caused by several post harvest diseases such as Whiskers rot and Blue and Black rot which caused by *Rhizopus stolonifer, Penicillium expansum* and *Aspergillus niger*, (Sharma *et al.,* 1990).

A - Effect on loss in apricot fruit weight:

Data from Table (1) show clearly that the loss in fruit weight was gradually increased at cold storage as the storage period advanced. Yet, the loss in fruit weight was 3.2% for untreated fruits under cold storage. Whereas, $CaCl_2$ applications at 1% or 2% reduced the percent of loss in fruit weight than those treated with GA_3 or carbendazim . These results could be due to the effect of calcium on reducing the respiration rate by maintaining membrane integrity and inhibited C_2H_4 production, (Wills and Tirmazi, 1982). Also, Nijjar (1985) presented that calcium application reduced the respiration rate by inhibiting the activities of respiratory enzymes such as pyrovate kinase.

Table (1): Effect of preharvest treatments on loss in apricot fruit weight percentage.

Treatment	Season 2002			Season 2003		
	Storage period in days					
	10	20	30	10	20	30
Control	1.58	1.69	3.18	1.38	1.57	3.18
$CaCl_2$ 1%	1.34	1.50	2.01	1.34	1.53	2.28
$CaCl_2$ 2%	0.89	1.13	1.90	0.86	1.30	1.99
GA_3 25 ppm	0.71	1.14	2.48	0.60	1.26	2.65
GA_3 50 ppm	0.93	1.19	2.90	0.98	1.35	2.80
Carbendazim750 ppm	0.72	1.09	2.00	0.85	1.25	2.00
L.S.D at 5%	For period = 0.04 For treatments = 0.06 For interaction = 0.11			For period = 0.03 For treatments = 0.05 For interaction = 0.08		

In this respect, $CaCl_2$ at 2% reduced the loss in fruit weight than spraying with 1%, since this treatment reduced the percent of loss in fruit weight significantly than the other treatments or the control at cold storage. Furthermore Spraying apricot trees with both GA_3 or carbendazim reduced the percentage of loss in fruit weight than the control, but the effect of these treatments almost lower than $CaCl_2$ application. Whereas carbendazim at 750 ppm gave a more pronounced effect on loss in fruit weight than GA_3 applications or the control. Since, the loss in fruit weight due to this treatment was about 2% after 30 days from cold storage as a mean of the two seasons .That is due to its effect on reducing respiration rate and inhibited ethylene production, (Romero *et al*., 2000).

B - Effect on decayed fruits :

It is obvious from Table (2) that all treatments used produced no decayed fruit till 20 days of cold storage. Thus, Carbendazim at 750 ppm showed no decayed fruits till 30 days under cold conditions. Thus, the percent of decayed fruits for the control reached about 5.9 % at cold storage as a mean of the two seasons .

Regarding to the effect of $CaCl_2$, GA_3 and carbendazim applications on the percent of decayed fruits, the data also reveal that carbendazim at 750 ppm was superior in this respect, so no decayed fruits had obtained during cold storage till 30 days. That is astonishing since carbendazim gives protection from post harvest spoilage of apricot caused by *Rhizopus stolonifer*, (Sharma *et al.,* 1990). Also, carbandazim delayed decayed fruit through its effectiveness on controlling shot-hole, (Aurang *et al.,* 2000). Moreover, GA_3 application also reduced the percent of decayed fruits than $CaCl_2$ treatments or the control.

In this respect GA_3 especially at 25 ppm presented about 2.4% decayed fruits but the untreated fruits ranged about 5.9 % decayed fruit for after 30 days of cold storage as mean of the two seasons. That is mainly due to the effect of GA_3 application on decreasing the extent of gel breakdown of Canino apricot, (Weksler *et al*., 2001) . Also GA_3 reduced respiration rate and

this is correlated to an inhibition damaged zone showed tissue disruption, cellular juice leakage and browning that could be related to maillard reaction, or to enzymatic oxidation of of phenolics substances by polyphenoloxidase in presence of oxygen, (Romero *et al*., 2000).

Whereas, $CaCl_2$ at 1% or 2% also reduced the percent of decayed fruits than the control. So, the percent attributed due to these treatment averaged 5.1 and 4.4 % after 30 days of cold storage as mean of the two seasons . The obtained results could be explain by that calcium treatment greatly inhibite the activity of *Penicillium expansum*, polyglacturonase enzyme as well as provided broadspectrum protection against postharvest pathogens and that is due to the effect of the applied Ca^{2+} on increasing cell wall calcium content which helps in maintaining fruit firmness to resist decay by certain pathogens, (Conway *et al*., 1991). At least $CaCl_2$ has a good resistance to *Monilina fructicola* as it reduced the increase of enzymatic activity and brown rooting which caused by *M. fructicola*, (Souza *et al*., 1999).

Table (2): Effect of preharvest treatments on apricot decayed fruit percentage.

Treatment	Season 2002			Season 2003		
	Storage period in days					
	10	20	30	10	20	30
Control	0.00	0.00	5.39	0.00	0.00	6.43
$CaCl_2$ 1%	0.00	0.00	4.50	0.00	0.00	5.63
$CaCl_2$ 2%	0.00	0.00	4.15	0.00	0.00	5.44
GA_3 25 ppm	0.00	0.00	1.50	0.00	0.00	3.38
GA_3 50 ppm	0.00	0.00	3.21	0.00	0.00	3.99
Carbendazim750 ppm	0.00	0.00	0.00	0.00	0.00	0.00
L.S.D at 5%	For period = 0.17 For treatments = 0.24 For interaction = 0.41			For period = 0.10 For treatments = 0.14 For interaction = 0.24		

C - Effect on total loss in fruit weight:

Total loss in fruit weight is mainly due to the loss in fruit weight and decayed fruits presented in Table (3). From this data it is clear that total loss in fruit weight was gradually increased as storage period advanced under cold storage. Carbendazim application at 750 ppm reduced the total loss in fruit weight significantly than the other treatment used. Since the percentage of total loss in fruit weight due to these treatments was about 2% after 30 days at cold storage. That is not astonishing since, this treatment reduced both loss in fruit weight and more effective for reducing the percentage of decayed fruit than GA_3 or $CaCl_2$ applications. The obtained data are similar to (Gouramanis, 1999).

Furthermore, GA_3 treatment especially at 25 ppm reduced the percent of total loss in apricot fruits than GA_3 at 50 ppm or $CaCl_2$ applications at 1% or 2% .

Table (3): Effect of preharvest treatments on total loss in weight of apricot fruit.

Treatment	Season 2002			Season 2003		
	Storage period in days					
	10	20	30	10	20	30
Control	1.58	1.69	8.57	1.38	1.57	9.61
$CaCl_2$ 1%	1.34	1.50	6.51	1.34	1.53	7.91
$CaCl_2$ 2%	0.89	1.13	6.05	0.86	1.30	7.43
GA_3 25 ppm	0.71	1.14	3.60	0.60	1.26	5.90
GA_3 50 ppm	0.93	1.19	6.11	0.98	1.35	6.79
Carbendazim750ppm	0.72	1.09	2.00	0.85	1.25	2.00
L.S.D at 5%	For period = 0.22 For treatments = 0.31 For interaction = 0.53			For period = 0.10 For treatments = 0.14 For interaction = 0.24		

Also, $CaCl_2$ reduced the percent of total loss than the control may be due to its effect on reducing weight loss and decayed fruit than the control and the data go in line with those presented by Souza et al., 1999 and Weksler *et al*., 2001 .

2 - Effect on fruit pulp firmness:

Data from Table (4) show that the firmness of apricot fruit pulp was reduced significantly as cold storage period prolonged. Since, the values of pulp firmness of the untreated fruits was 2.4 $lb.in^{-2}$ after 30 days of cold storage as a mean of two seasons. The data also revealed that, the reduction in pulp firmness was little with $CaCl_2$ applications especially when applied at 2 %. So, the values of pulp firmness due this treatment was almost higher than those obtained from GA_3 or carbendazim under cold storage during both seasons. These result are mainly due to that Ca plays an important role in maintaining cell wall integrity and polyuronide solubilization in fruits by interacting with the uronic acids in the cell walls to form calcium pectate, (Poovaiah, 1986).

Table (4): Effect on apricot pulp firmness ($lb . in^{-2}$).

Treatment	Season 2002				Season 2003			
	Storage period in days							
	0	10	20	30	0	10	20	30
Control	7.00	6.10	4.83	2.67	7.50	5.93	5.07	2.13
$CaCl_2$ 1%	8.10	7.37	5.97	2.97	8.43	7.63	5.70	2.93
$CaCl_2$ 2%	8.53	7.87	5.93	3.37	8.77	7.80	5.87	3.43
GA_3 25 ppm	9.53	8.10	6.00	3.17	9.27	8.27	6.30	3.20
GA_3 50 ppm	7.97	7.50	5.27	2.77	8.67	7.93	5.43	2.93
Carbendazim750ppm	7.33	6.73	6.47	3.03	8.13	6.97	6.43	3.20
L.S.D at 5%	For period = 0.11 For treatments = 0.14 For interaction = 0.28				For period = 0.20 For treatments = 0.25 For interaction = 0.49			

Likewise, the values of apricot pulp firmness were almost higher with GA_3 especially at 25 ppm. That is not astonishing since GA_3 increased the ratio of cell wall to cell volume in fruit from GA_3 treated trees due to greater cell numbers, leading to improved fruit firmness, (Southwick *et al.,* 1995).

3 - Effect on SSC/acid ratio:

Data from Table (5) presented that the values of SSC/acid ratio was gradually increased as the storage period advanced at cold storage. That is not astonishing, since the content of SSC was increased but the total acidity in fruit juice was gradually reduced with the storage period advanced. Also, the changes in SSC/acid ratio in fruit juice during cold storage for all treatments was unpronounced. These results might be due to the effect of treatments on decreasing SSC and increasing total acidity percentages in fruit juice during storage comparing with the control. The data also is agreement with those reported by (Abbott *et al.,* 1992).

Table (5): Effect on SSC/acid ratio in apricot fruit juice.

Treatment	Season 2002				Season 2003			
	Storage period in days							
	0	10	20	30	0	10	20	30
Control	6.6	8.5	14.9	17.8	6.5	8.6	14.4	17.5
$CaCl_2$ 1%	6.1	7.7	11.3	12.6	5.8	7.7	12.5	13.3
$CaCl_2$ 2%	5.4	6.5	10.5	12.2	5.1	6.7	11.4	12.7
GA_3 25 ppm	5.4	6.9	12.7	14.0	5.2	7.0	11.6	13.2
GA_3 50 ppm	6.2	8.0	13.5	16.2	5.7	8.0	13.3	16.0
Carbendazim750ppm	5.6	7.6	12.1	13.4	5.9	7.8	12.2	13.8
L.S.D at 5%	For period = 0.3 For treatments = 0.4 For interaction = 0.7				For period = 0.3 For treatments = 0.4 For interaction = 0.8			

4 - Effect on total carotenoids:

It is clear from Table (6) that GA_3 application at 50 ppm or $CaCl_2$ at 1 % significantly reduced the content of total carotenoids in apricot fruit than the other treatments used or the untreated fruits at harvest time. This result may be due to that $CaCl_2$ caused a general delay in appearance of full orange colour, typical of ripe fruit, (Schirra *et al.,* 1997). Furthermore, GA_3 at 25 ppm or $CaCl_2$ at 2 % gave higher values of total carotenoids than those treated with GA_3 at 50 ppm or carbendazim. The low values of carotenoids which obtained from GA_3 comparing with control may be due to that GA_3 delayed peel colour development in apricot fruit, (Weksler *et al.,* 2001).

Moreover, all treatments used significantly reduced the values of total carotenoids in apricot fruit than the control at harvest time during both seasons under the study. That is not astonishing, since these treatments reduced the values of SSC/acid ratio in fruit juice. These results agreed with those obtained by (Kundal *et al.,* 2000) on plum .

Table (6): Effect on total carotenoids of apricot fruit.

Treatment	Season 2002				Season 2003			
	Storage period in days							
	0	10	20	30	0	10	20	30
Control	2.35	2.58	4.19	4.72	2.33	2.58	4.21	4.59
$CaCl_2$ 1%	1.82	1.98	2.53	3.89	1.82	1.98	2.51	3.91
$CaCl_2$ 2%	2.19	2.74	3.14	3.40	2.15	2.74	3.14	3.39
GA_3 25 ppm	2.16	2.44	3.10	3.42	2.16	2.46	3.19	3.42
GA_3 50 ppm	1.73	1.89	2.91	3.27	1.75	1.89	2.91	3.32
Carbendazim750ppm	1.99	2.01	2.13	3.80	1.99	2.06	2.13	3.80
L.S.D at 5%	For period = 0.01 For treatments = 0.01 For interaction = 0.03				For period = 0.02 For treatments = 0.02 For interaction = 0.04			

The values of total carotenoids was gradually increased as storage period prolonged from harvest till 30 days at cold storage. Furthermore, the values attributed from all treatments were almost lower than those obtained from the untreated fruit at cold storage during both seasons of study and the obtained data go in line with those presented by Khader, 1992 & Southwick and Yeager, 1995 .

From this study, it can be concluded that spraying apricot trees two weeks before harvest with carbendazim at 750 ppm was effective for reducing decay fruit percentage at cold storage. Since, carbendazim at 750 ppm is very safety and keeping the quality of apricot fruit characteristics for one month after harvest time. Furthermore, spraying trees with GA_3 at 25 ppm and $CaCl_2$ at 2% enhanced fruit firmness, reduced the percent of decayed fruit and the total loss in fruit weight of apricots fruit. Also, these treatments keept fruit quality of apricots and lead to extend marketing period of apricot fruit in Egyptian emporiums.

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تأثير المعاملة ببعض المواد الكيماوية قبل الحصاد على جودة و قدرة ثمار المشمش التخزينية

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أجريت هذه الدراسة خلال موسمي ٢٠٠٢-٢٠٠٣ لدراسة تأثير الرش بكل من كلوريد الكالسيوم, حمض الجبرليك و الكاربيندازيم كمعاملات قبل الحصاد على صفات ثمار المشمش وقت الحصاد و على القدرة التخزينية لهاخلال التخزين البارد.

و لتنفيذ هذه الدراسة تم جمع ثمار المشمش عند مرحلة اكتمال النمو عندما وصلت الثمار لاكتمال التلوين ووصلت الصلابة حوالي ٧ ـ ٨ رطل / بوصة^{2}. حيث تم فرز الثمار لاستبعاد المصابة والتالفة ثم وضعها تحت ظروف التخزين البارد على درجة حرارة ٢ ± ١ م° و رطوبة نسبية ٩٠-٩٥ % لمدة ٣٠ يوم.

أهم النتائج المتحصل عليها:-

١- أدت جميع المعاملات المستخدمة إلى زيادة في صلابة الثمار عن الثمار الغير معاملة وقت الجمع في حين أظهر الرش بكلوريد الكالسيوم بتركيز ٢% وكذا حمض الجبريليك بتركيز ٢٥ جزء في المليون زيادة في صلابة الثمار عن باقي المعاملات المستخدمة .

٢- أدى الرش الرش بالكاربيندازيم بتركيز ٧٥٠ جزء في المليون إلى تقليل نسبة التالف وكذا الفقد الكلى فى وزن الثمار مقارنة بالمعاملة بكل من حمض الحبريلك وكلوريد الكالسيوم والتي أعطت نتائج أفضل من الثمار الغير معاملة . علاوة على ذلك فإن جميع المعاملات المستخدمة أدت لخفض محتوى ثمار المشمش من الكاروتينات الكلية بالمقارنة بتلك الثمار الغير معاملة .

٣- جميع المعاملات المستخدمة أدت لخفض الفقد الكلى في وزن ثمار المشمش مع المحافظة علي جودة الثمار بالإضافة إلي أن جميعها أمنه علي صحة الإنسان.

من خلال هذه الدراسة, يمكن التوصية برش أشجار المشمش قبل الجمع بأسبوعين بمادة الكاربيندازيم بتركيز ٧٥٠ جزء فى المليون وذلك لما لها من تأثير فعال على خفض نسبة الثمار التالفة بدرجة ملحوظة خلال التخزين البارد و كذلك المحافظة على صفات الجودة لثمار المشمش لمدة شهر بعد الجمع. و كما أن الرش بحمض الجبرليك بتركيز ٢٥ جزء فى المليون و كذا كلوريد الكالسيوم بتركيز ٢% يحسن من صلابة الثمار مع خفض نسبة الثمار التالفة و كذلك نسبة الفقد الكلى فى وزن الثمار مع احتفاظها بالصفات الكيميائية المرغوبة لدى المستهلك وذلك تحت ظروف التخزين البارد مما يؤدى لإطالة الفترة التسويقية لثمار المشمش فى الأسواق المصرية.