EFFECT OF SOME PREHARVEST TREATMENTS ON QUALITY AND RIPENING OF “CANINO” APRICOT FRUITS

III. DEVELOPMENTAL ASPECTS AND THE SHELF LIFE OF APRICOTS.

KARIM M. FARAG¹, AMR M. HAikal¹ AND SAID M. ATTIA¹

¹Department of Horticulture, Faculty of Agriculture, Damanhour University, P.O.Box 22516, Damanhour, Egypt.

ABSTRACT

This study was conducted during two successive seasons 2007 and 2008 by using "Canino" apricot cultivar (Prunus armeniaca L.) grafted on Balady apricot rootstock. Trees were grown at El-Noubarya region, Behera, Egypt. Treatments included water as the control, ethephon at 200 ppm alone or in a combination with either CaCl₂ or oleic acid, in addition to oleic acid at 400 ppm and CaCl₂ (2 %,w/v), the non ionic surfactant Tween 80 at 0.1% (v/v) was added to all treatments. Trees were sprayed with a hand sprayer to the run off. The trees received the treatments at one application time either at pit hardening or at the early coloration stage (15-20% fruit coloration). The first application time was at pit hardening (8th, 2nd May during 2007 and 2008 respectively), while the second application time was at 15 – 20 % fruit coloration (23, 16 May during 2007 and 2008 respectively). The trees were sprayed at the time corresponding to specific fruit growth stages established by monitoring the progress of the double sigmoid curve and the hardening of the endocarp. Various physical and chemical parameters were monitored at weekly intervals following the treatments until harvest especially fruit size, diameter, weight and flesh weight. In this study, modification of the growth curve following the treatment was focused on fruit size and weight and was represented by many figures. It was evident that fruits of this cultivar followed a
clear double sigmoid curve with the three distinguished phases. Some treatments were still able to modify the curve early in the third phase. The more pronounced modification was obtained with oleic acid treatments at 400 ppm whether in the presence or absence of ethephon when applied at pit hardening. On the other hand, applied treatments at 15-20% fruit coloration, did not have considerable modification on apricot fruits double sigmoid curve. On the other hand, the changes in the shelf life of such fruit in response to applied treatments before harvest were assessed at the end of shelf period, (at ambient temperature (22± 2°C) for three days) applied treatments such as ethephon alone or in the presence of either CaCl₂ or oleic acid at pit hardening caused a significant increasing in carotenes, reducing sugars, TSS/ acidity ratio and decreased chlorophyll a, b and acidity. The incorporation of CaCl₂ with ethephon had no consistent influence on weight loss. Meanwhile, the incorporation of oleic acid with ethephon did not cause a significant change in weight loss. On the other hand, oleic acid–treated fruits decreased weight loss, fruit firmness, chlorophyll a, b and increased carotenes, TSS/ acidity, while, did not cause a significant change in fruit firmness, total sugars, reducing sugars and non-reducing sugars when compared with the control. In addition, at the end of shelf period applied treatments such as ethephon alone or in the presence of either CaCl₂ or oleic acid at 15-20% fruit coloration caused a significant increase in carotenes, reducing sugars, TSS/ acidity ratio and decreased acidity. Furthermore, they did not cause a significant change in weight loss, fruit firmness, chlorophyll a, b and non-reducing sugars. Moreover, ethephon-treatment alone at 15- 20% coloration caused an increase in weight loss and reduced fruit firmness. However, oleic acid–treatment increased carotenes, reducing sugars, TSS/ acidity and decreased acidity. Meanwhile, it did not cause a significant change in weight loss, fruit firmness, chlorophyll a, b, total...
sugars and non-reducing sugars as compared with the control. It was evident that the application of oleic acid mitigated the damaging effect of ethephon especially on fruit firmness, while, oleic acid alone improved important quality attributes such as carotenes and TSS to acidity.

INTRODUCTION

Many new cultivars have been introduced to the Egyptian agriculture and were adopted by producers especially under arid cultivations. Apricot is one of the desired fruits due to its multiple use and utilization and its nutritious value. "Canino" is one of the relatively new cultivars in Egypt and much more information is needed to document the extend of its adaptation to harsh conditions prevailing in desert agriculture in spite of its limited chilling requirements. To manipulate fruit ripening and coloration of apricots, treatments were either applied at pit hardening or at color initiation.

There has been a lack of information about the changes occurring in fruit growth curve especially with relatively new agents used to hasten and improve color intensity of apricots under desert agriculture conditions. Many cultivars of temperate region origin may have a change in their developmental aspects of their fruits. For example, absorption of embryos may occur which leads to the absence of the second phase of the double sigmoid curve of the fruit (Tukey, 1963). There is a need to monitor any modifications of that curve whether the duration of the second phase or and changes in the third phase of the double sigmoid curve depending on the time of application especially with the newly introduced compounds either alone or in a formulation. On the other hand, it is very critical to investigate the possibility of any alterations in the shelf life of the fruit as a result of field treatments. Apricot fruits are climacteric and highly perishable, thus exhibit short-storage and shelf life which limit their commercial potential and cause great losses during their marketing.
It has been shown in previous parts of these studies that oleic acid (at 400 ppm) has the potential to be used as a color enhancer of apricot fruits without sacrificing the tissue firmness at harvest. Furthermore, the formulation of ethephon plus oleic acid and a surfactant were able to enhance and hasten color development of “Canino” apricots without any adverse effects on critical fruit characteristics such as fruit size and weight.

Thus, the objectives of this part were to monitor the development aspects of Canino apricots and document any alterations due to applying ethephon alone or in combination with oleic acid or calcium in comparison with just applying oleic acid or calcium alone either at pit hardening or at color initiation. Another important aspect of this research was to document the changes in the shelf life of such fruit in response to applied treatments before harvest.

MATERIALS AND METHODS

The present study was conducted during the two successive seasons 2007 and 2008 using Canino apricot trees (*Prunus armeniaca* L.) grown in a private orchard at Nubaria region, Beheira governorate, Egypt. The trees were five years old spaced at 4×6 m, trees were healthy, uniform, free from visible defect or various disorders and budded on “Balady” apricot rootstock, and under standard agricultural practices. Soil texture was sandy and drip irrigation system was adopted with all trees. Applications were made by spraying apricot trees either at pit hardening (8th, 2th May during 2007 and 2008 respectively) or at color initiation (15 – 20% fruit coloration) on May 23, 16 during the two the two seasons, respectively). The treatments included water as the control, ethephon at 200 ppm, oleic acid at 400 ppm, CaCl$_2$ 2% (w/v) alone or in a combination with either ethephon or oleic acid, the non-ionic surfactant tween 80 at 0.1% (v/v) was added to all treatments. Various physical and chemical parameters were monitored at weekly intervals following the treatments until harvest. The treatments were arranged in a factorial experiment in randomized complete block design, three replications were used for each treatment and one tree represented one replication.
The shelf life test was carried out by storing a sample of 10 fruits per replication on $(22+2^0 \, \text{c})$ and three replicates were used with each treatment, after three days, the following measurements were taken: the final weight (gm) which was then used to determine the weight loss percentage. Fruit firmness was determined as $(\text{lb/in}^2)$ using Effigi pressure tester (mod. Ft327), then results of these measurements were converted to $(\text{Newton})$ using the following equation: $\text{Newton} = \text{lb/in}^2 \times 4.448$. TSS$\%$ was determined in apricot fruit juice using a hand refractometer. While the acidity was determining calorimetrically based on estimated malic acid using five milliliters of the fruit juice of each fruit sample and titrated with sodium hydroxide solution of a known normality using phenolphthalein as an indicator (A.O.A.C., 1985). Reduced sugars were determined according to the Lane and Eynon colorimetric method as described by (Egan et al., 1981). Total sugars were determined by using the phenol sulfuric acid method (Smith, 1956), and the concentration was calculated from a standard curve of glucose mg. per gm. fresh weight of fruit tissue. Chlorophylls $a,b$ and Beta-Carotene were determined according to (Winterman's and Mats, 1965) by using spectrophotometer.  

Data were analyzed as a factorial arrangement in a randomized complete block design with three replicates. Comparisons among means were made via the Least Significant Differences multiple ranges (LSD) according to Sendecor and Cochran (1980). The data were analyzed using SAS (2000).

**RESULTS AND DISCUSSION**

I. Developmental Aspects of Fruit in Relation to the Treatments:

Monitoring some morphological aspects of “Canino” apricot fruits such as fruit size, diameter, weight and flesh weight throughout different phases of growth and development provided data through the season to draw the growth curve. It was evident that fruits of this cultivar followed a clear double sigmoid curve with the three distinguished phases. Like all members of the subfamily “Prunoideae” (Tukey, 1936), three stages of development are recognized, describing growth in terms of a double sigmoid pattern (Jackson, 1965). In stage I, cell division is rapid and accompanied towards the end of the
period by cell expansion with rapid increase in pericarp volume; stage II is a period of relative quiescence in the pericarp and rapid development of the embryo, while in stage III, the endocarp completes its development and the pericarp resumes rapid increase in volume which is predominantly, due to cell expansion (Jackson and Coombe, 1966 a, b) and (Sterling, 1935). In early maturing varieties, including those varieties with a low requirement for winter chill, stage II is compressed and endocarp closure may not be completed when the pericarp is mature (Lilleland, 1930 and 1935).

This study took the approach of manipulating fruit ripening by treating fruits at pit hardening or in third phase of development to affect ethylene production that increases with climacteric. It appeared that the first phase of rapid enlargement following fruit set was approximately of similar rate and duration for many apricot fruit varieties. Fruits of early maturing cultivars were characterized by aborted embryos and absence of intermittent growth. Midseason apricot cultivars were found to have a relatively short duration of phase two of the double sigmoid curve. Meanwhile, those of later maturation showed prominent retardness in the second stage and gave rise to fully developed embryos (Tukey, 1936), emphasized the above information. Through monitoring the changes in fruit size of “Canino” apricot cultivar during the two seasons (figures 1 -4), a typical double sigmoid curve was obtained with a relatively short duration in second phase. Some treatments were still able to modify the curve early in the third phase. The more pronounced modification was obtained with oleic acid treatments at 400 ppm whether in the presence or absence of ethephon. This effectiveness of oleic acid could be related to its ability to influence the membrane permeability, rigidity, fluidity and regulation of cellular functions (Maxfield and Tabas, 2005) and (Overath et al, 1970).

With regard to development aspects of fruit diameter, the curves illustrated again the formation of a double sigmoid pattern. The second phase of slow or ceased growth is clearer than that obtained with fruit size in most cases. The change in fruit diameter during the first phase did not have a sharp slope as obtained in the third phase. This explained the greater growth rate in the last phase as compared with the first phase in fruit diameter. Again, the more pronounced modification of the third phase was obtained with oleic acid
at 400 ppm without or with ethephon. The application of calcium did not show a clear modification in the slope of fruit diameter curve during the third phase.

Responses of fruit weight to the application of various treatments in terms of modifying the growth curve were illustrated in Figures (5 -8). Ethephon at 200 ppm without or with calcium, a reduction in fruit weight as compared with the control, the growth curves showed that this reduction required a prolonged period during the third phase of fruit development. On the other hand, oleic acid applications at 400 ppm whether in the absence or presence of ethephon resulted in a clear modification in the slope of fruit weight curve during the third phase. Thus, oleic acid was still effective in increasing tissue weight up to the harvest time. In addition, the double sigmoid curve showed a smooth transition between phase one and three which indicated to a relatively short duration of the second phase of the developmental curve. It was also obvious that calcium chloride treatment did not lead to noticeable modification in the third phase of double sigmoid curve during both seasons.

Changes in the flesh weight of “Canino” apricot throughout different phases of the growth curve were also monitored. The double sigmoid curves were not as clear as other presented curves since flesh weight data were taken relatively late starting on May 16 and 9 in both seasons, respectively, which coincided with the beginning of pit hardening. Developmental aspects of the flesh weight were only followed during the last two phases. The reduction of flesh weight by ethephon whether in the absence or presence of CaCl$_2$ appeared to last for several weeks. On the contrary, the increase in flesh weight by oleic acid at 400 ppm without or with ethephon 400 ppm appeared to be more pronounced in the last two weeks proceeding harvest especially oleic acid treatments alone. Moreover, no clear distinction between the curves of calcium chloride-treated apricots and those of control were found. All above information was about treatments applied at pit-hardening. On the other hand, applied treatments at 15-20% fruit coloration, which did not have more modification on apricot fruits double sigmoid curve (Figures 9 -12) emphasized the above information.
Fig 1 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit size of "Canino" apricot fruits as treated with ethephon 200 ppm (at pit hardening) throughout the two growing seasons 2007 and 2008, respectively.
Fig 2 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit size of "Canino" apricot fruits as treated with oleic acid 400 ppm (at pit hardening) throughout the two growing seasons 2007 and 2008, respectively.
Fig 3 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit size of "Canino" apricot fruits as treated with ethephon 200 ppm+CaCl₂ 2% (at pit hardening) throughout the two growing seasons 2007 and 2008, respectively.
Fig 4 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit size of "Canino" apricot fruits as treated with ethephon 200 ppm + oleic acid 400 ppm (at pit hardening) throughout the two growing seasons 2007 and 2008, respectively.
Fig 5 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit weight of "Canino" Apricot fruits as treated with ethephon 200 ppm (at pit hardening) throughout the two growing seasons 2007 and 2008, respectively.
Fig 6 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit weight of "Canino" apricot fruits as treated with oleic acid 400 ppm (at pit hardening) throughout the two growing seasons 2007 and 2008, respectively.
Fig 7 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit weight of "Canino" apricot fruits as treated with ethephon 200 ppm+ CaCl₂ 2% (at pit hardening) throughout the two growing seasons 2007 and 2008, respectively.
Fig 8 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit weight of "Canino" apricot fruits as treated with ethephon 200 ppm + oleic acid 400 ppm (at pit hardening) throughout the two growing seasons 2007 and 2008, respectively.
Fig 9 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit size of "Canino" apricot fruits as treated with ethephon 200 ppm (at 15-20% fruit coloration) throughout the two growing seasons 2007 and 2008, respectively.
Fig 10 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit size of "Canino" apricot fruits as treated with oleic acid 400 ppm (at 15-20% fruit coloration) throughout the two growing seasons 2007 and 2008, respectively.
Fig 11 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit size of "Canino" apricot fruits as treated with ethephon200 ppm + oleic acid 400 ppm (at 15-20% fruit coloration) throughout the two growing seasons 2007 and 2008, respectively.
Fig 12 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit weight of "Canino" apricot fruits as treated with oleic acid 400 ppm (at 15-20% fruit coloration) throughout the two growing seasons 2007 and 2008, respectively.

II. Shelf Life Assessment:
ILA. Application at Pit Hardening

Assessing the shelf life parameters after the incubation of apricot fruits at ambient temperature (22±2°C) proved that many applied treatments at pit hardening caused a significant reduction in weight loss such as CaCl$_2$, oleic
Firmness of "Canino" apricot fruits treated at pit hardening at the end of shelf life period was reported in Table 1. The data proved that ethephon caused a significant reduction in fruit firmness by the end of the shelf life period in both seasons when compared with the control. Meanwhile, CaCl$_2$ treatment resulted in a significant increase in fruit firmness relative to the control. In fact, the highest tissue firmness was obtained with CaCl$_2$ treatment. On the other hand, oleic acid-treated fruits had similar firmness to that found in the control fruits but higher firmness than that obtained with ethephon treatment in both seasons. The addition of oleic acid to ethephon also resulted in higher firmness than that obtained with ethephon alone. Thus, oleic acid was able to mitigate the adverse effect of ethephon on the shelf of apricot fruits at ambient temperature (Table 1). Similar results were found when the effect of ethephon alone was compared with that of ethephon plus CaCl$_2$ in both seasons.

Changes in chlorophyll a after the shelf life period of apricot fruits treated at pit hardening were also assessed in Table 1. The data showed that all treatments caused a significant reduction in chlorophyll a as compared with the control in both seasons. However, various treatments varied in the magnitude of such reduction. For example, ethephon treatment alone or in the presence of either CaCl$_2$ or oleic acid in addition to oleic acid alone had similar magnitude of reduction of chlorophyll a but resulted in significant higher reduction than that found with CaCl$_2$ treatment in both seasons. Meanwhile, the data revealed
that there was a significant reduction in chlorophyll b in apricot fruits caused by either CaCl₂, oleic acid, ethephon plus CaCl₂ or ethephon plus oleic acid when compared with the control in both seasons. However, CaCl₂-treated fruits had similar chlorophyll b content to that found in the control fruits at the end of the shelf life period. Furthermore, ethephon and oleic acid treatments were equally effective in reducing chlorophyll b in "Canino" apricots at the end of the shelf life period. The incorporation of either CaCl₂ or oleic acid to ethephon did not result in additional reduction in chlorophyll b when compared with the application of ethephon alone (Table 1).

The data of carotenes at the end of the shelf life period of "Canino" apricots treated at pit hardening was also reported in Table 1. The data proved consistent evidence that pre-harvest treatments with either ethephon, CaCl₂, oleic acid, or ethephon plus either CaCl₂ or oleic acid were able to increase carotenes in the fruits as compared with the control. However, the high carotene content in "Canino" fruits was obtained with ethephon treatment. Oleic acid alone was able to cause a significant increase in carotenes as compared with the control. The presence of either CaCl₂ or oleic acid along with ethephon resulted in lower carotenes than that obtained with ethephon alone in both seasons.

Total sugars changes at the end of the shelf life as influenced by various treatments at pit hardening were also determined. The data showed that total sugars were significantly increased by ethephon treatment over the control. However, such sugars did not significantly vary from the control when the fruit was treated before harvest at pit hardening by either CaCl₂, oleic acid, or ethephon plus CaCl₂. The combination of ethephon plus oleic acid resulted in greater total sugars than the control at the end of the shelf life period. Furthermore, ethephon-treated fruits were superior in their total sugars over oleic acid-treated ones or ethephon plus CaCl₂-treated fruits.

However, response of reducing sugars at the end of the shelf life period varied from total sugars, the data revealed that ethephon alone or its combination with either CaCl₂ or oleic acid caused a significant increase in reducing sugars as compared with the control in both seasons. The combination of ethephon plus oleic acid resulted in greater reducing sugars than fruits treated with ethephon plus CaCl₂. Meanwhile, neither CaCl₂ nor
oleic acid was able to significantly affect reducing sugars relative to the control. The highest percentage of reducing sugars was obtained with ethephon plus oleic acid among various treatments but was not significantly different from ethephon alone (Table 1).

Assessment of non-reducing sugars in "Canino" apricot fruits at the end of the shelf life period revealed that the data took similar trend to that found with total sugars (Table 1). It was evident that ethephon-treated fruits had significantly higher percentage of non-reducing sugars in both seasons as compared with the control. However, CaCl$_2$, oleic acid, or ethephon plus CaCl$_2$ gave similar results to that found in the control fruits with regard to the percentage of non-reducing sugars in the fruit. Furthermore, the formulation containing ethephon plus oleic acid resulted in a significant increase in such sugars relative to the control.

With regard to the total soluble solids data as affected by various treatments at pit hardening, the data in general showed that at the end of shelf life period "Canino" fruits contained greater percentage of TSS than the control, in both seasons. However, CaCl$_2$ did not cause a significant change in TSS relative to the control. Furthermore, the obtained TSS values with ethephon alone did not significantly vary from those obtained with the combination of ethephon plus CaCl$_2$ or oleic acid in both seasons. On the other hand, oleic acid alone did not result in a consistent change in TSS in both seasons when compared with the control.

Acidity values at the end of the shelf life period as influenced by various applied treatments at pit hardening showed that there was a significant reduction of such acidity caused by ethephon alone or in the presence of CaCl$_2$ or oleic acid in both seasons when compared with the control. The effect of CaCl$_2$ or oleic acid alone on fruit acidity by the end of the shelf life period was not consistent between the two seasons relative to the control. The highest acidity was found in the control fruits.

Furthermore, the TSS to acidity ratio at the end of the shelf life period was also influenced by pre-harvest application of various treatments at pit hardening. The data proved that there was a significant increase in such ratio by ethephon treatment alone or in the presence of CaCl$_2$ or oleic acid in both seasons. Ethephon-treated fruits tended to have greater TSS to acidity at the
end of the shelf life period when compared with oleic acid-treated fruits. On the other hand, \(\text{CaCl}_2\) spray at pit hardening did not cause a significant alteration in the TSS to acidity as compared with the control in both seasons.

The above data regarding the effect of various applied treatments at pit hardening on the shelf life of "Canino" apricot fruits were in line with those found by Schomer et al. (1971), Mann et al. (1986), Conway et al. (1995), Tzoutzoukou and Bouranis (1997), (Gerasopoulos and Richardson, 1997), Raese and Drake (1998), Raese et al. (1999), Hussein et al. (2001), Bertolini et al. (2002), Drake et al. (2005), Drake et al. (2006) and Moor et al. (2006).

Rease et al. (1999) reported that calcium chloride sprays increased \(\text{Ca}^{2+}\) concentration in apricot fruits and improved shelf-life by increasing fruit firmness, fruits held longer in cold storage (50 days) had higher concentrations of \(\text{Ca}^{2+}\), lower soluble solids, sucrose, glucose and fructose and were less firm and had less acid than those in short term storage. Recently, Picchioni et al. (1995) reported that the effects of Ca on lipid content and composition of outer cortical tissue showing an increase of all lipid classes in Ca treated fruit at the end of storage.

The positive effect of oleic acid on the shelf life whether alone or when incorporated with ethephon could be attributed to its effect on the membrane fluidity at ambient temperature which led to retarding the aging and senescence of apricot fruits, maintaining the fruit health, and mitigating the adverse effects of ethephon on the membrane and cell wall structure.

II.B. Applications at 15-20% fruit coloration:

Assessing the shelf parameters after the incorporation of apricot fruits at ambient temperature (22±2°C) for 3 days (Table 2) proved that some applied treatments at 15-20% coloration caused a significant increase in weight loss by the end of the shelf life period such as ethephon in both seasons as compared with the control while its combination with either \(\text{CaCl}_2\) or oleic acid did not cause such increase in weight loss. Thus, the presence of either \(\text{CaCl}_2\) or oleic acid along with ethephon alleviated its adverse effect on weight loss at ambient temperature. Furthermore, \(\text{CaCl}_2\) or oleic acid treatment did not lead to increase in such loss. Hence, the most adverse effect on weight loss was obtained with ethephon that caused even considerably greater weight loss.
than those found in the fruits treated with CaCl$_2$ or oleic acid alone in both seasons (Table 2).

The effect of various treatments applied at 15-20% coloration on the firmness of "Canino" apricots after 3 days on the shelf was reported in Table 2. The data indicated that there was a significant reduction in fruit firmness caused by ethephon applied at 15-20% coloration while CaCl$_2$ caused a significant increase in such firmness in both seasons. Meanwhile, the incorporation of CaCl$_2$ or oleic acid into ethephon led to avoiding the adverse effect obtained with ethephon alone on fruit firmness. Additionally, the application of oleic acid alone did not lead to an increase in fruit firmness as compared with the control in both seasons. Furthermore, oleic acid-treated fruits had significantly higher fruit firmness than those treated with ethephon alone in both seasons. Even the combination of ethephon plus oleic acid led to a significant reduction in fruit firmness as compared with the application of oleic acid alone in a consistent manner.

With regard to chlorophyll a content in "Canino" apricots influenced by various treatments at the end of the shelf life period, the data in Table 2 showed that there was a significant reduction in chlorophyll a in fruit skin caused by ethephon application at 15-20% coloration as compared with the control. Meanwhile, CaCl$_2$ or oleic acid-treated fruits did not vary in their chlorophyll a from those of the control. Similarly, the application of either ethephon plus CaCl$_2$ or plus oleic acid did not lead to any significant change in chlorophyll a as compared with the control or ethephon alone in both seasons. Moreover, CaCl$_2$-treated fruits had higher chlorophyll a content than that found in ethephon-treated ones in both seasons.

Monitoring chlorophyll b content in Canino apricot cultivar at the end of the shelf life period (Table 2) revealed that ethephon alone did not consistently change chlorophyll b as compared with the control. However, oleic acid-treated fruits had higher chlorophyll b than those treated with ethephon alone after 3 days on the shelf. Meanwhile, neither ethephon nor oleic acid-treated fruits varied in their chlorophyll b content from those treated with ethephon plus CaCl$_2$ or oleic acid in both seasons.

Carotene content in the skin of "Canino" apricot fruits at the end of the shelf life period was reported in Table 2. The data provided evidence that
ethephon-treated fruits had higher carotenes than the control fruits. However, 
CaCl$_2$-treated fruits at 15-20% coloration had similar carotenes in the skin at 
the end of the shelf life period relative to the control. On the other hand, oleic 
acid-treated fruits had significantly higher carotenes than the control fruits in 
both seasons. Furthermore, the combination of ethephon plus oleic acid led to 

carotenes in the fruits similar to that found in ethephon-treated fruits by 
significantly greater amount of carotenes than those found in ethephon plus 
CaCl$_2$-treated fruits in both seasons. In addition, ethephon-treated fruits had 
higher carotenes than those treated with oleic acid at the end of the shelf life 
test.

Total sugars data at the end of the shelf life period as influenced by 
various treatments applied at 15-20% coloration were reported in Table 2. The 
data showed that various treated fruits had total sugars similar to that of the 
control except ethephon alone or in the presence of oleic acid that tended to 
have more total sugars as compared with the control. Furthermore, ethephon- 
treated fruits had considerably greater total sugars than those treated with 
CaCl$_2$ or oleic acid alone in both season after three days on the shelf.

Reducing sugars data of Canino fruits at the end of the shelf life test as 
fluenced by various treatments were reported in Table 2. The data revealed 
that ethephon-treated fruits had significantly higher percentage of reducing 
sugars than the control in both seasons while CaCl$_2$ did not significantly affect 
these sugars. Meanwhile, oleic acid was affective in increasing reducing 
sugars over the control but was still similar to ethephon in its influence on 
these sugars. The combination of ethephon plus either CaCl$_2$ or oleic acid 
resulted in greater amount of reducing sugars in the fruit at the end of the shelf 
life period when compared with the control. However, ethephon-treated fruits 
were still superior in their reducing sugar content over those treated with its 
combination with either CaCl$_2$ or oleic acid. The content of reducing sugars 
obtained with either ethephon or oleic acid alone did not vary from each other 
in both seasons.

Non-reducing sugars in the fruit of Canino apricot cultivar was also 
influenced by various treatments at the end of the shelf life period (Table 2). 
Even though, various treated fruits had similar non-reducing sugars to that 
found in the control fruits, some treatments led to higher non-reducing sugars
percentage over the others. For example, ethephon-treated fruits had similar non-reducing sugars to those treated with the combination of ethephon plus oleic acid, but both treatments induced higher content of these sugars than that found in CaCl₂ and oleic acid treated fruits in both seasons (Table 2).

Effect of pre-harvest treatments at 15-20% fruit coloration on the TSS at the end shelf life of "Canino" apricot fruits was reported in Table 2. It was evident that ethephon-treated fruits had significantly higher TSS than that of the control. However, oleic acid-treated fruits did not significantly vary from the control in their TSS content in both seasons. In a similar manner, CaCl₂ and ethephon in the presence of oleic acid did not lead to a significant increase in TSS at the end of the shelf life period over the control.

Changes in acidity of "Canino" apricots as affected by various treatments were also recorded at the end of the shelf life period and reported in Table 2. There was a consistent and significant reduction in Canino fruit acidity caused by many treatments such as ethephon alone or in the presence of CaCl₂ or oleic acid, and by oleic acid alone as compared with the control in both seasons. However, the effect of CaCl₂ on reducing fruit acidity was only significant in the first season over the control fruits. Furthermore, there was no significant difference between the effect of ethephon or oleic acid on such acidity at the end of the shelf life period (Table 2).

The TSS/ acidity ratio at the end of the shelf life period as influenced by the pre-harvest treatments at 15-20% coloration was recorded and reported in Table 2. The data showed that there was a significant increase in the TSS to acidity by many treatments such as ethephon, oleic acid, and the combination of ethephon plus CaCl₂ or oleic acid as compared with the control in both seasons. However, CaCl₂-treated fruits did not vary in their TSS to acidity ratio from the control fruits. Moreover, the addition of oleic acid to ethephon did not significantly alter such ratio as compared with the effect of ethephon alone in both seasons. Meanwhile, oleic acid-treated fruits tended to have lower TSS/ acidity ratio relative to ethephon alone (Table 2).
REFERENCES


الملخص العربي

تأثير بعض المعاملات قبل الجمع على جودة و نضج ثمار المشمش صنف الكانيئو وعلى حياتها على الأرفف تأثير المعاملات على حياتها على الأرفف

كريم محمد فرج – عمرو محمد هيكل – سعيد محمد علي
قسم البساتين (فاكهة) ، كلية الزراعة، جامعة دمنهور، رقم صندوق بريد 22516، دمنهور- مصر.

أجريت هذه الدراسة خلال موسمي 2007 و 2008 باستخدام أشجار المشمش صنف كانيئو المطعومه على أصل المشمش البلدي المنزرعة في منطقة البحيرة بمحافظة البحيرة ، جمهورية مصر العربية، وقد تم رش الأشجار باستخدام رشاشات بديعة حتى نقطة الجرائ السطحي واشتملت المعاملات
على الكنتنرول(رش بالماهاء) ، الايثيون بتركيز 200 جزء في المليون بمرفزة أو مخلوط مع كلوريد الكالسيوم أو حمض الأليليك بالإضافه لحمض الأليليك بتركيز 400 جزء في المليون، وتقميد الكالسيوم بتركيز % وزن/حجم، وتم استخدام المادة النازعة تونين 80 تركيز 0.1% (حجم/حمج) لكل المعاملات. وقد تم رش الأشجار مرة واحدة في أحد مياديننا أسماء تخبسب النواة (2)، 8 مايو خلال عامي 2008 و2007 على الترتيب)، وقد تم تثبيب منحنى نمو الثمار على قنوات مثلة بعد العدّ وذلك عقب العملية باسبوع حتى أكتمال النمو. وعند هذه الدراسة تم تثبيب غرف معتمة حمام النازعة خاصة على الملائمين حما النازعة وحوزنها.

ووجد أن الثمار قد أثبتت منحنى نمو زيجودي مزدوج وكان الثائر الملحوظ تحور هذا المنحنى بعد إجراء المعاملات نتيجة لاستخدام حمض الأليليك في مرحلة تخشب النواة خاصة في اخر اسبوعين قبل الخض، بينما لم تثبيب أي المحالات بشكل ينطلق على هذا المنحنى، وأحد أن كل المعاللات غير مؤثرة على تحور منحنى نمو الثمار عندما تمت المعالمات عند بداية تلوين الثمار (15-20% تلوين للثمار)، كما تم تقسيم نتائج المعالقات على حياوات الثمار على الارط وحوزنها، وبشكل مشابه نوجة الثمار عند شراء علامة (22 ± 2 م).

وفي نهاية فترة اختبار حيا الثمار بعد القط، في وجود كلوند الكالسيوم وحمض الأليليك عند مرحلة نكود النازعة وحص من الكاروتينات، السكرات المختزلة، نسبة المواد الصلبة الدائمة إلى الحموضة، كما أدى إلى تقليل كلوروفيل، كلفي، اللحمية، كما أدى خلط كلوريد الكالسيوم مع الأليليك إلى تثار، غير ثائر على حيا الثمار كما لم تثبيب تركيبة حمض الأليليك بطريقة معنوية على مدى الوزن، وحل النازعة من الكاروتينات، السكرات المختزلة،، السكرات الكلية، السكرات المختزلة، والسكرات غير مملوءة بالكنتنرول، كما جاد أنه في نهاية فترة اختبار حيا الثمار بعد القط، إعتضات المعالقات كانت أقل من مرحلة النازعة أو في وجود كلوند الكالسيوم وحمض الأليليك عند شراء علامة (22 ± 2 م).
Table (1) Effect of various applied treatments at pit hardening during the two seasons 2007 and 2008 on some physical and chemical properties of "Canino" apricots at the end of the shelf life period.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Weight loss %</th>
<th>Firmness (Newton)</th>
<th>chlorophyll a (mg/L)</th>
<th>chlorophyll b (mg/L)</th>
<th>Carotene (mg/100 gm)</th>
<th>Total Sugars %</th>
<th>Reducing sugars %</th>
<th>Non-reducing Sugars %</th>
<th>TSS%</th>
<th>Acidity %</th>
<th>TSS/Acidity%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>14.106 b</td>
<td>14.862 a</td>
<td>29.164 b</td>
<td>29.164 b</td>
<td>0.123 a</td>
<td>0.117 a</td>
<td>0.601 cd</td>
<td>0.504 cd</td>
<td>7.081 c</td>
<td>7.583 c</td>
<td>6.480 c</td>
</tr>
<tr>
<td>Ethephon 200 ppm</td>
<td>17.978 c</td>
<td>16.190 a</td>
<td>19.393 d</td>
<td>17.629 c</td>
<td>0.069 c</td>
<td>0.065 c</td>
<td>0.007 c</td>
<td>0.183 c</td>
<td>4.499 a</td>
<td>4.636 a</td>
<td>9.105 a</td>
</tr>
<tr>
<td>CaCl₂ 2%</td>
<td>10.595 c</td>
<td>11.644 b</td>
<td>43.97 a</td>
<td>47.416 a</td>
<td>0.101 c</td>
<td>0.095 c</td>
<td>0.020 c</td>
<td>0.015 c</td>
<td>2.641 c</td>
<td>2.668 c</td>
<td>6.818 d</td>
</tr>
<tr>
<td>Oleic acid 400 ppm</td>
<td>10.782 cd</td>
<td>12.149 b</td>
<td>31.329 b</td>
<td>31.877 b</td>
<td>0.064 c</td>
<td>0.056 c</td>
<td>0.008 c</td>
<td>0.015 c</td>
<td>3.977 b</td>
<td>4.125 b</td>
<td>7.513 d</td>
</tr>
<tr>
<td>Ethephon 200 ppm + CaCl₂ 2%</td>
<td>12.120 c</td>
<td>13.058 a</td>
<td>37.081 b</td>
<td>36.132 b</td>
<td>0.077 c</td>
<td>0.071 c</td>
<td>0.012 bc</td>
<td>0.012 bc</td>
<td>4.907 b</td>
<td>4.123 b</td>
<td>7.648 bc</td>
</tr>
<tr>
<td>Ethephon 200 ppm + Oleic acid 400 ppm</td>
<td>14.264 b</td>
<td>15.275 a</td>
<td>30.261 c</td>
<td>30.61 b</td>
<td>0.068 c</td>
<td>0.058 c</td>
<td>0.014 bc</td>
<td>0.014 bc</td>
<td>4.019 b</td>
<td>4.053 b</td>
<td>8.398 ab</td>
</tr>
</tbody>
</table>

*Values, within a column, of similar letters are not significantly different according to the least significant difference (LSD) at 0.05 levels.

*Newton=lb/in² × 4.448.
Table (2) Effect of various applied treatments at 15-20 % fruit coloration during the two seasons 2007 and 2008 on some physical and chemical properties of "Canino" apricots at the end of the shelf life period.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Weight loss %</th>
<th>Firmness (Newton)</th>
<th>chlorophyll a (mg/L)</th>
<th>chlorophyll b (mg/L)</th>
<th>Carotene (mg/100 gm)</th>
<th>Total Sugars %</th>
<th>Reduced sugars %</th>
<th>Non-reducing Sugars %</th>
<th>TSS%</th>
<th>Acidity %</th>
<th>TSS/Acidity%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>13.801</td>
<td>b</td>
<td>13.540</td>
<td>bc</td>
<td>34.042</td>
<td>bc</td>
<td>29.609</td>
<td>b</td>
<td>0.138</td>
<td>a</td>
<td>0.130</td>
</tr>
<tr>
<td>Ethephon 200 ppm</td>
<td>17.315</td>
<td>a</td>
<td>16.040</td>
<td>d</td>
<td>27.118</td>
<td>c</td>
<td>19.349</td>
<td>b</td>
<td>0.058</td>
<td>b</td>
<td>0.049</td>
</tr>
<tr>
<td>CaCl₂ 2%</td>
<td>11.758</td>
<td>b</td>
<td>12.192</td>
<td>a</td>
<td>48.720</td>
<td>a</td>
<td>55.170</td>
<td>a</td>
<td>0.119</td>
<td>a</td>
<td>0.111</td>
</tr>
<tr>
<td>Oleic acid 400 ppm</td>
<td>12.93</td>
<td>b</td>
<td>11.516</td>
<td>c</td>
<td>36.311</td>
<td>c</td>
<td>29.016</td>
<td>b</td>
<td>0.103</td>
<td>ab</td>
<td>0.095</td>
</tr>
<tr>
<td>Ethephon 200 ppm + CaCl₂ 2%</td>
<td>12.386</td>
<td>b</td>
<td>12.098</td>
<td>bc</td>
<td>37.823</td>
<td>b</td>
<td>36.681</td>
<td>c</td>
<td>0.101</td>
<td>ab</td>
<td>0.092</td>
</tr>
<tr>
<td>Ethephon 200 ppm + Oleic acid 400 ppm</td>
<td>13.449</td>
<td>b</td>
<td>13.976</td>
<td>ab</td>
<td>30.484</td>
<td>cd</td>
<td>20.905</td>
<td>c</td>
<td>0.110</td>
<td>ab</td>
<td>0.080</td>
</tr>
</tbody>
</table>

*Values, within a column, of similar letters are not significantly different according to the least significant difference (LSD) at 0.05 levels.