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EFFECT OF SOME PREHARVEST TREATMENTS ON QUALITY AND RIPENING OF "CANINO" APRICOT FRUITS
III. DEVELOPMENTAL ASPECTS AND THE SHELF LIFE OF APRICOTS.

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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 $CaCl_2$ or oleic acid , in addition to oleic acid at 400 ppm and $CaCl_2$ (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^{O}C) for three days) applied treatments such as ethephon alone or in the presence of either $Cacl_2$ 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 $CaCl_2$ 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 $CaCl_2$ 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

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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 emberyos 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.

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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.

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The shelf life test was carried out by storing a sample of 10 fruits per replication on ($22+2^0$ 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 (Ib/in2) using Effigi pressure tester (mod. Ft327), then results of these measurements were converted to (Newton) using the following equation: Newton= Ib/in2 * 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.

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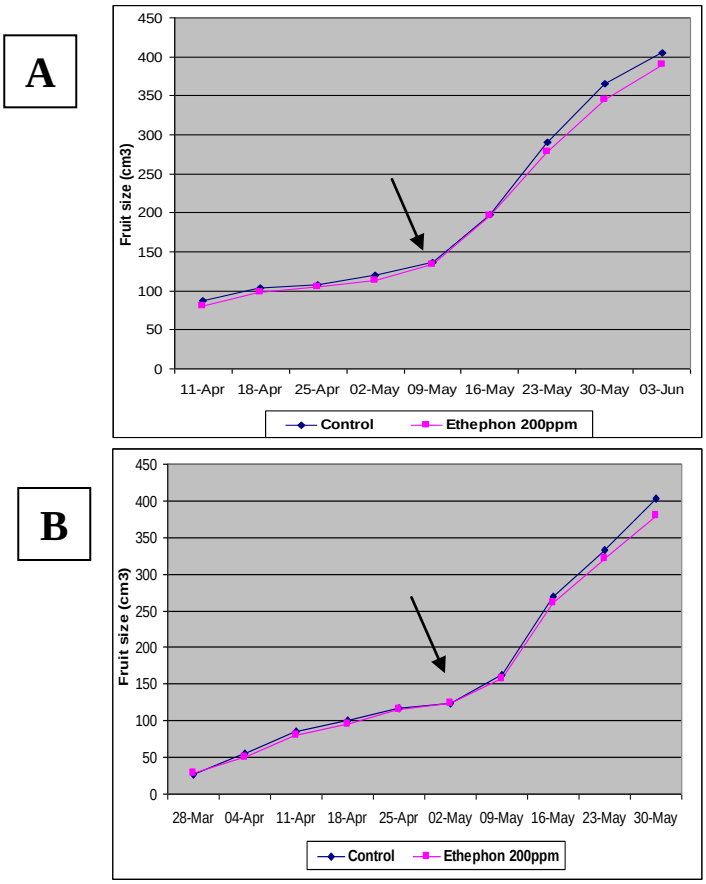

Fig 1 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit size of "Canino" apricot fruits as treated with ethephon 200 ppm (at pit hardening) throughout the two growing seasons 2007 and 2008, respectively.

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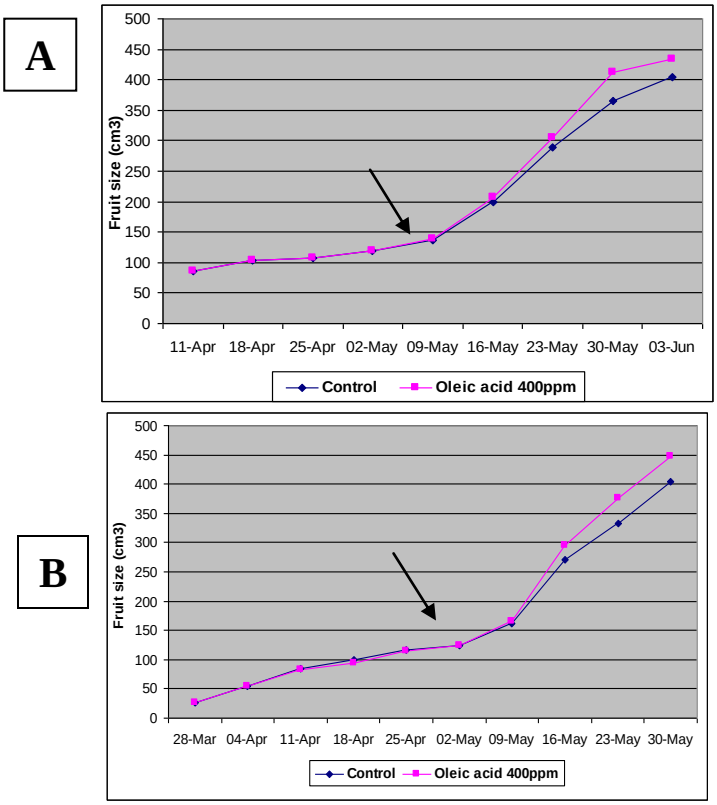

Fig 2 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit size of "Canino" apricot fruits as treated with oleic acid 400 ppm (at pit hardening) throughout the two growing seasons 2007 and 2008, respectively.

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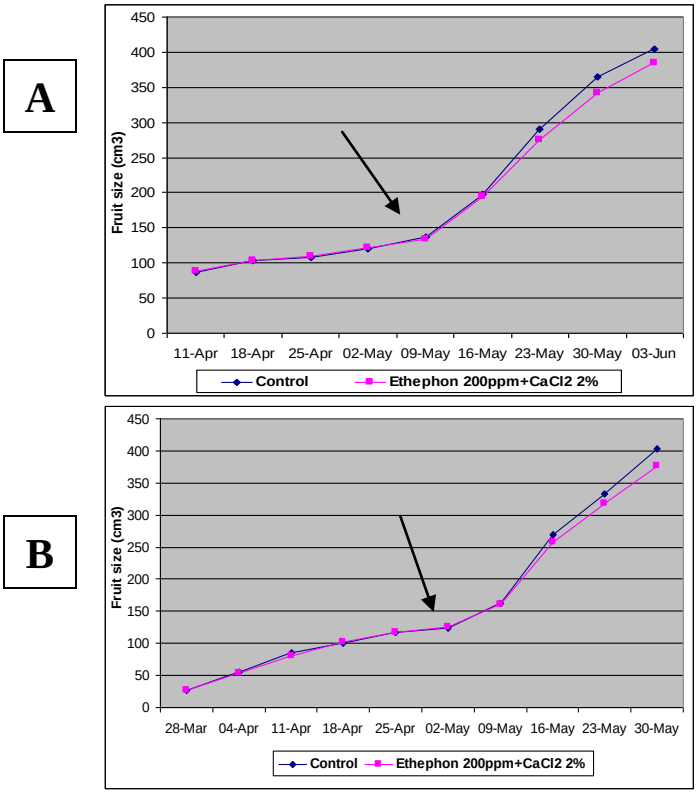

Fig 3 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit size of "Canino" apricot fruits as treated with ethephon 200 ppm+$CaCl_2$ 2% (at pit hardening) throughout the two growing seasons 2007and 2008, respectively.

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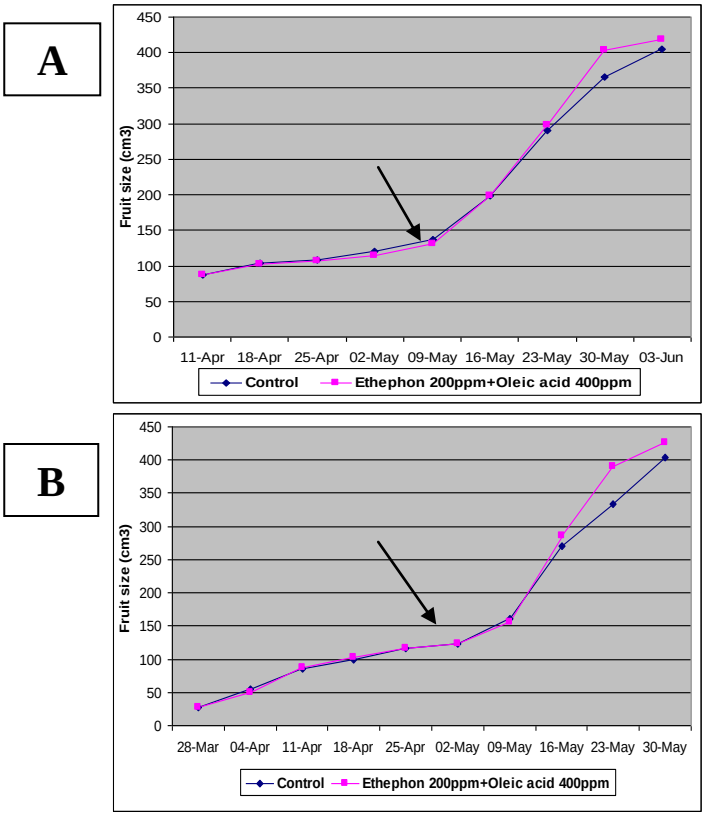

Fig 4 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit size of "Canino" apricot fruits as treated with ethephon200 ppm+ oleic acid 400 ppm (at pit hardening) throughout the two growing seasons 2007 and 2008, respectively.

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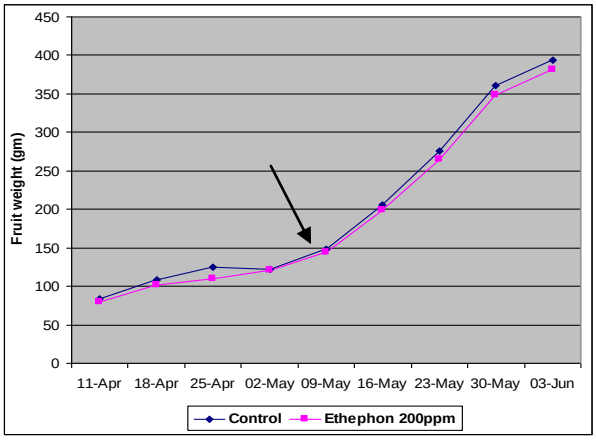
A



B

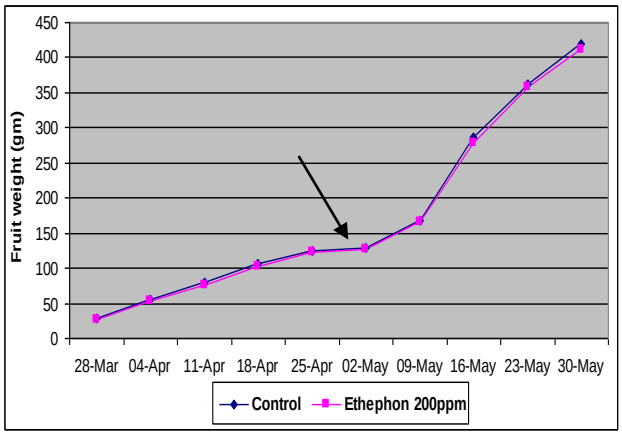


Fig 5 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit weight of "Canino" Apricot fruits as treated with ethephon 200 ppm (at pit hardening) throughout the two growing seasons 2007 and 2008, respectively

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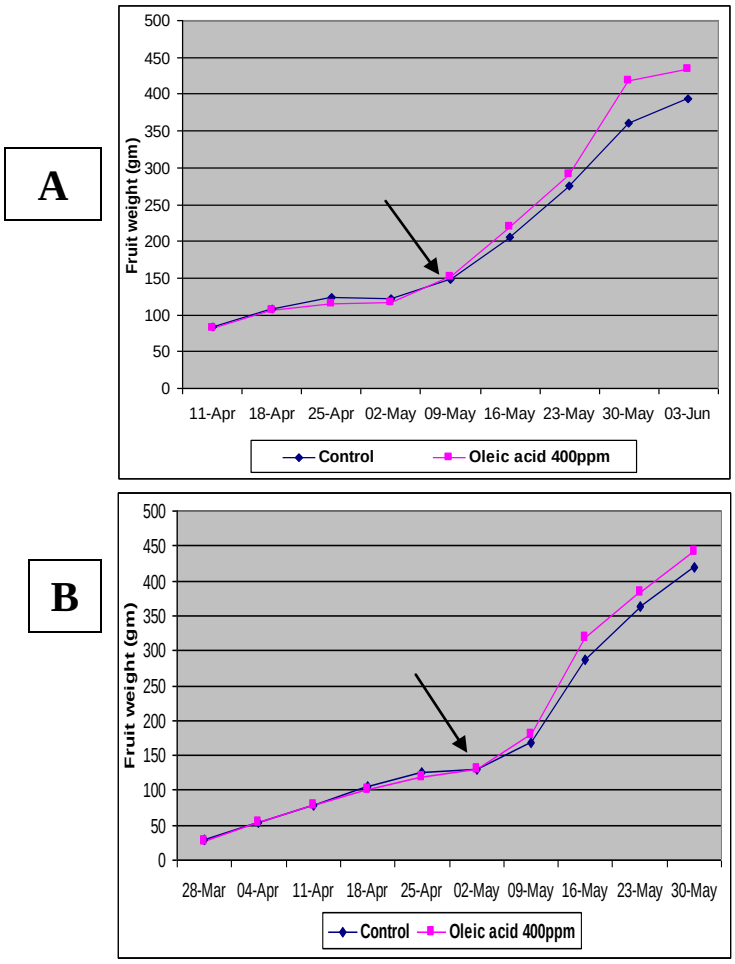

Fig 6 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit weight of "Canino" apricot fruits as treated with oleic acid 400 ppm (at pit hardening) throughout the two growing seasons 2007 and 2008, respectively.

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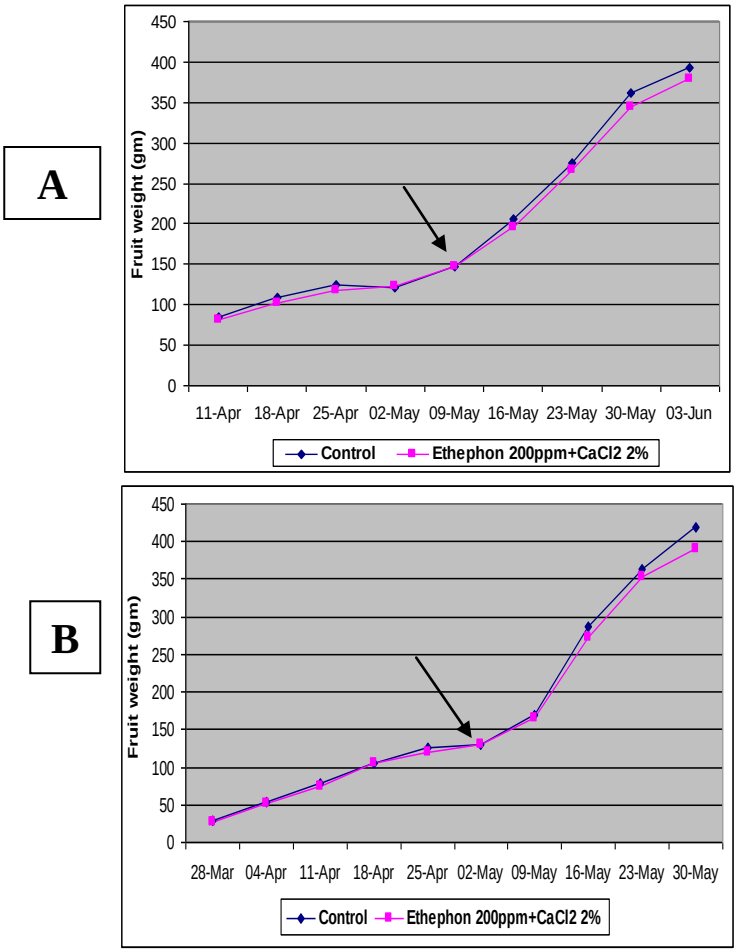

Fig 7 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit weight of "Canino" apricot fruits as treated with ethephon 200 ppm+ $CaCl_2$ 2% (at pit hardening) throughout the two growing seasons 2007and 2008, respectively

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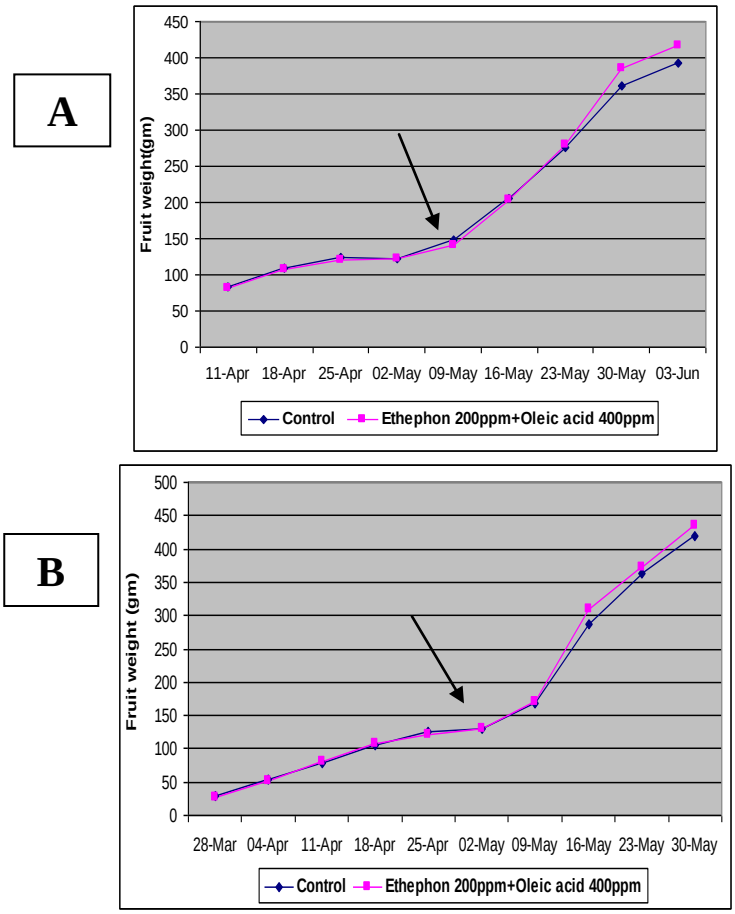

Fig 8 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit weight of "Canino" apricot fruits as treated with ethephon 200 ppm+ oleic acid 400 ppm (at pit hardening) throughout the two growing seasons 2007 and 2008, respectively.

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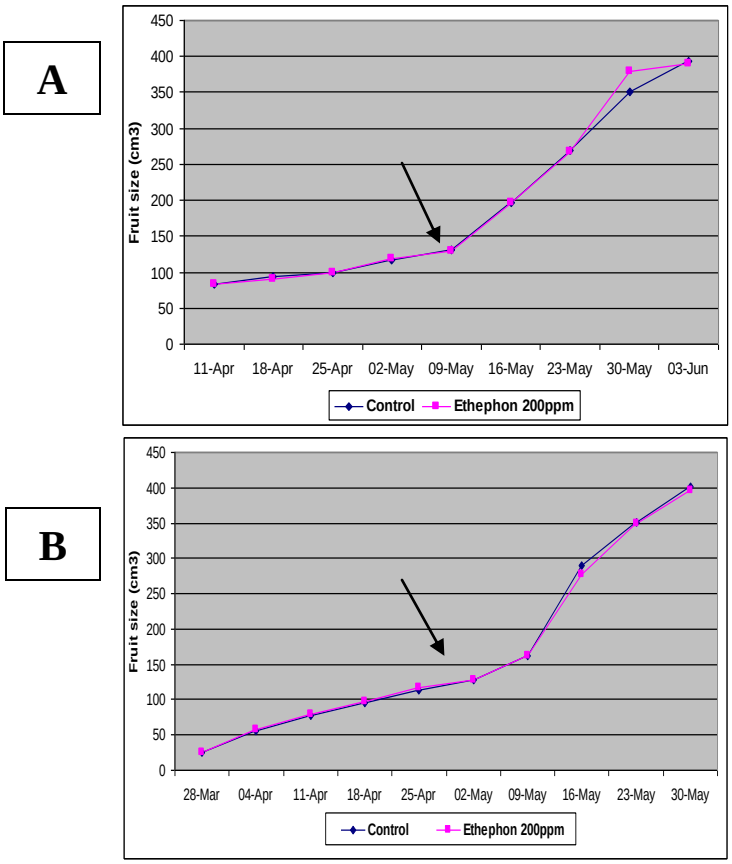

Fig 9 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit size of "Canino" apricot fruits as treated with ethephon 200 ppm (at 15-20%fruit coloration) throughout the two growing seasons 2007 and 2008, respectively.

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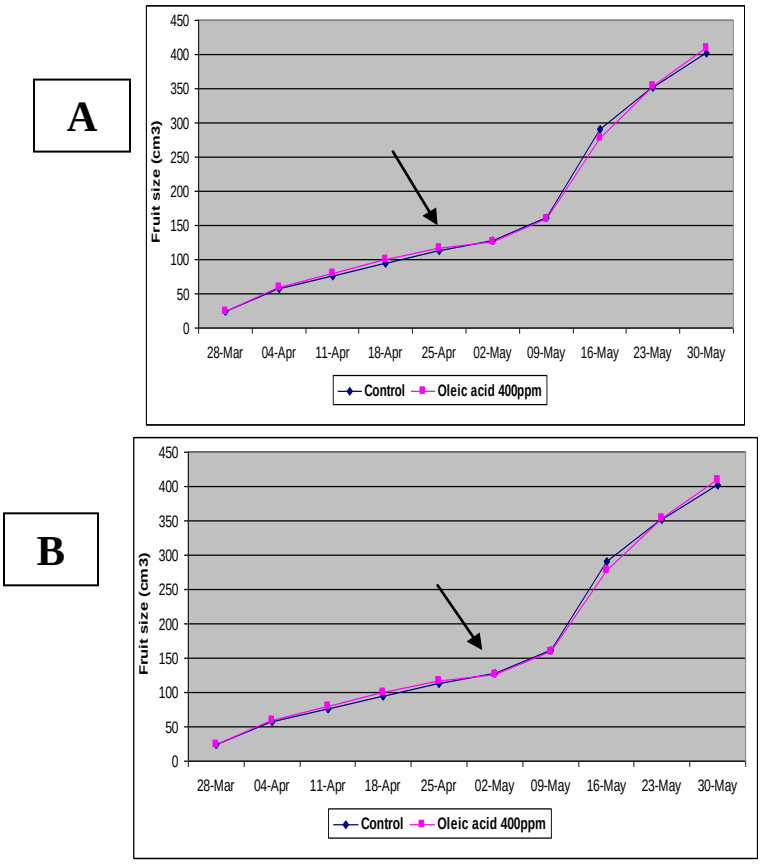

Fig 10 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit size of "Canino" apricot fruits as treated with oleic acid 400 ppm (at 15-20%fruit coloration) throughout the two growing seasons 2007 and 2008, respectively.

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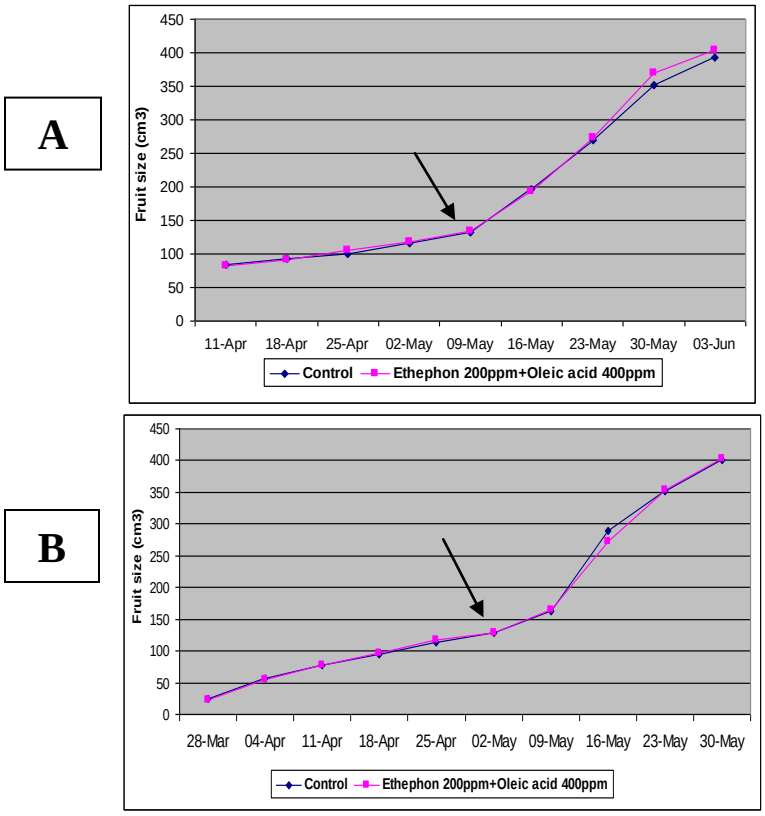

Fig 11 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit size of "Canino" apricot fruits as treated with ethephon200 ppm + oleic acid 400 ppm (at 15-20%fruit coloration) throughout the two growing seasons 2007 and 2008, respectively.

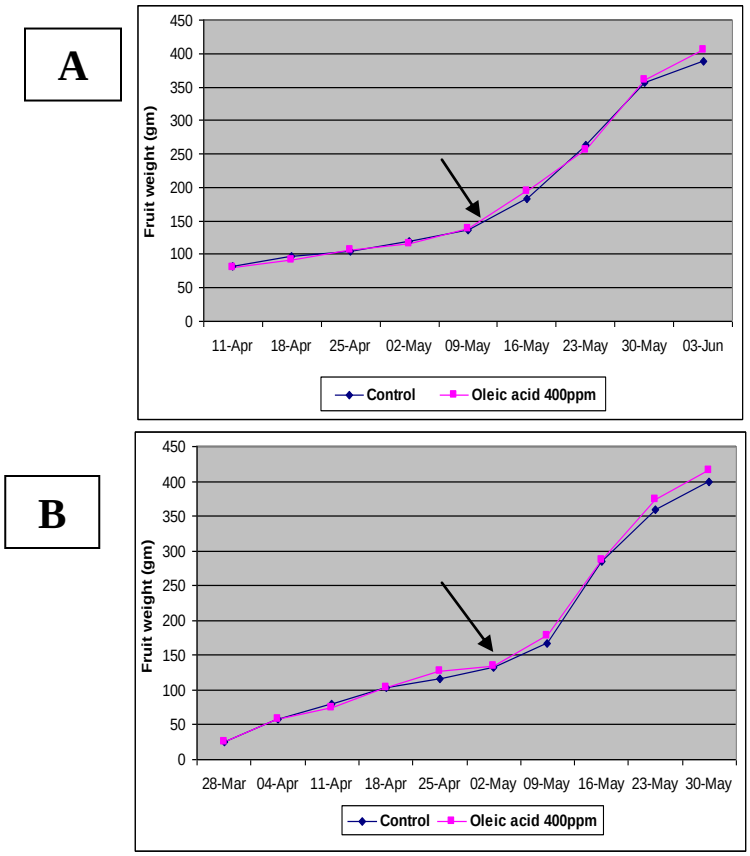

Fig 12 (A, B). The double sigmoidal curve generated by monitoring the changes in fruit weight of "Canino" apricot fruits as treated with oleic acid 400 ppm (at 15-20%fruit coloration) throughout the two growing seasons 2007 and 2008, respectively.

II. Shelf Life Assessment:

II.A. 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

acid, and ethephon plus $CaCl_2$ as compared with the control in both seasons (Table 1). Meanwhile, ethephon plus oleic acid resulted in a similar weight loss to that found in the control fruit in both seasons. While ethephon alone led to a significant increase in weight loss only in the first season but tended to increase it in the second season relative to the control. Moreover, ethephon-treated fruits caused a significant increase in weight loss as compared with $CaCl_2$, oleic acid and ethephon plus $CaCl_2$. On the other hand, oleic acid treatment was consistent in reducing weight loss when compared with the control or ethephon-treated fruits in both seasons. The incorporation of oleic acid into ethephon solution mitigated the increase in weight loss caused by ethephon alone since that loss did not vary between the control and ethephon plus oleic acid (Table 1).

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 $CaCl_2$, oleic acid, ethephon plus $CaCl_2$ or ethephon plus oleic acid when compared with the control in both seasons. However, $CaCl_2$-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 $CaCl_2$ 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, $CaCl_2$, oleic acid, or ethephon plus either $CaCl_2$ 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 $CaCl_2$ 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 $CaCl_2$, oleic acid, or ethephon plus $CaCl_2$. 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 $CaCl_2$-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 $CaCl_2$ 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 $CaCl_2$. Meanwhile, neither $CaCl_2$ 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

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end of the shelf life period when compared with oleic acid-treated fruits. On the other hand, $CaCl_2$ 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 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 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 ($22\pm2^{o}C$) 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 $CaCl_2$ or oleic acid did not cause such increase in weight loss. Thus, the presence of either $CaCl_2$ or oleic acid along with ethephon alleviated its adverse effect on weight loss at ambient temperature. Furthermore, $CaCl_2$ 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

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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 $CaCl_2$-trteated 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 influenced 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 $CaCl_2$ 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, $CaCl_2$ 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 $CaCl_2$ or oleic acid, and by oleic acid alone as compared with the control in both seasons. However, the effect of $CaCl_2$ 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 $CaCl_2$ or oleic acid as compared with the control in both seasons. However, $CaCl_2$-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).

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REFERENCES

A.O.A.C. (1985). Official Methods of Analysis of the Association of Official analytical Chemists Washington, D.C. USA 14 Th Ed.

Bertolini, P; Guizzardi, M; Casadei,-C. (2002). Influence of calcium and oxygen levels on soft scald of stored 'Abbe Fetel' pears. Acta-Horticulturae; (596): 851-856.

Conway, W. S; Sams, C. E; Hickey, K. D. (1995). Commercial potential for increasing apple tissue calcium sufficiently to maintain fruit quality in storage. Postharvest-physiology,-pathology-and-technologies-for-horticultural-commodities: Recent Advances-Proceedings of an International Symposium Agadir Morocco, 70-74.

Drake, S. R; Eisele, T. A; Elfving, D. C; Drake, M. A; Drake, S. L; Visser, D. B (2005). Effects of the bioregulators aminoethoxyvinylglycine and ethephon on Brix, carbohydrate, acid, and mineral concentrations in 'Scarletspur Delicious' apple juice. HortScience; 40(5): 1421-1424.

Drake, S. R; Elfving, D. C; Drake, M. A; Eisele, T. A; Drake, S. L; Visser, D. B. (2006). Effects of aminoethoxyvinylglycine, ethephon, and 1-methylcyclopropene on apple fruit quality at harvest and after storage. HortTechnology; 16(1): 16-23.

Egan, H.; Kirk, R. S.; Sawyer, R. (1981). Pearson's chemical analysis of food: Churchill Livingstone, Edinburgh London, Melbourne and New York, pp591.

Gerasopoulos, D; and Richardson, D. G. (1997). Fruit maturity and calcium affect chilling requirements and ripening of 'd'Anjou' pears. HortScience; 32(5): 911-913.

Hussein, M. A, El-Mahdy, T. K; Ibrahim, A. A. (2001). Effect of calcium chloride and gibberellic acid treatments on Anna and Dorset Golden apples during storage. A- Physical characteristics of fruits. Assiut-Journal-of-Agricultural-Sciences.; 32(1): 233-250

Jackson, D. I. (1965). Study of growth in apricot fruit. Doctoral Thesis, Adelaide University. 113p.

Jackson, D. I. Coombe, BG (1966, a). Gibberellin-like substances in the developing apricot fruit. Science. 154, 277-278.

Jackson, DI; Coombe, BG (1966, b). The growth of apricot fruit. Australian Journal of Experimental Agriculture 17, 465-477.

Lilleland, O (1930). Growth study of the apricot fruit. Proceedings American Society Horticultural Science 27, 237-245.

Lilleland, O (1935). Growth study of the apricot fruit II: The effect of temperature. Proceedings American Society Horticultural Science 33, 264-279.

Mann, S. S; and Kushal-Singh. (1986). Effect of post-harvest application of Ethrel on ripening and quality of Patharnakh pear. Advances-in-Research-on-Temperate-fruits-Proceedings-of-the-national-symposium-on-temperate-fruits,-15-18 March.Himachal-Pradesh.

Maxfield, F.R., and Tabas, I.(2005). Role of cholesterol and lipid organization in disease. Nature 438, 36–45.

Moor, U; Toome, M; Luik, A. (2006). Effect of different calcium compounds on post-harvest quality of apple. Agronomy-Research; 4(2): 543-548.

Overath, P., Schairer, H. U. and Stofferl, W. (1970). Correlation of in vivo and in vitro phase transitions of membrane lipids in Escherichia coli. Pmc. Natn. Acad. Sci. U.S.A. 67, 606-612.

Picchioni, G. A., Watada, A. E., Conway, W. S., Whitaker, B. **D. and Sams, C. E. (1995).** Phospholipid, galactolipid, and steryl lipid composition of apple fruit cortical tissue following post harvest $CaCl_2$ infiltration. Phytochemistry 39: 763-769.

Raese, J.T; Drake, S. R; Staiff, D. C. (1999). Calcium sprays, time of harvest, and duration in cold storage affect fruit quality of d'Anjou pears in a critical year. Journal-of-Plant-Nutrition; 22(12): 1921-1929.

Raese, T; and Drake, S. R. (1998). Calcium sprays, harvest, and storage impacts on pear. Good-Fruit-Grower; 48(17): 70-73.

Schomer, H; Williams, M. W; Billingsley, H. D. (1971). Effect of combinations of growth regulators on maturity and quality of 'Tydeman's Red' apples. HortScience; 6(5): 453-455.

Smith, F. (1956). Colorimetric method for determination of sugar and related substance. Analytical Chemistry; 28: 350-356.

Snedecor, G. W. and W. G. Cochran. (1980). Statistical methods. 6th Ed. Iowa State Univ. Press, Ames, Iowa. USA .

Sterling, C. (1935). Developmental anatomy of the fruit of Prunus domestica L. Bulletin Torrey Botanical Club. 80, 457-477.

Tukey, B (1936). Development of cherry and peach fruits as affected by detraction of the embryo, Botanical Gazette 98, 1-24.

Tukey, L. D. (1963). A comparison of fruit sizing among early and late peach varieties. Fruit Var. Hort. Dig. 18:11-13.

Tzoutzoukou, C. G; Bouranis, D.L. (1997). Effect of pre-harvest application of calcium on the post-harvest physiology of apricot fruit. Journal-of-Plant-Nutrition. 20(2/3): 295-309.

Wintermans, j. F. G. M. and Mats D. E. (1965). Spectrophtometeric characteristics of chlorophylls and their pheophytins in ethanol. Biochem. Biophys. Acta. 448-453.

الملخص العربي

تأثير بعض المعاملات قبل الجمع على جودة و نضج ثمار المشمش صنف الكانينو وعلى حياتها على الأرفف
ثالثا: الملامح التطورية للثمار وتاثير المعاملات على حياتها على الارفف.

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أجريت هذه الدراسة خلال موسمي 2007 و 2008 باستخدام أشجار المشمش صنف كانينو المطعومه على أصل المشمش البلدي المنزرعة في منطقة النوبارية بمحافظة البحيرة ، بجمهورية مصر العربية، وقد تم رش الأشجار باستخدام رشاشة يدوية حتى نقطة الجريان السطحى و اشتملت المعاملات

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على الكنترول(رش بالماء) ، الإثيفون بتركيز200 جزء في المليون بمفردة أو مخلوط مع كلوريد الكالسيوم أو حمض الاوليك بالاضافة لحمض الاوليك بمفردة بتركيز 400 جزء في المليون، و كلوريد الكالسيوم بتركيز 2% (وزن/حجم)، وتم استخدام المادة الناشرة توين 80 بتركيز 0.1 % (حجم/ حجم) لكل المعاملات. و قد تم رش الأشجار مرة واحدة في احد ميعادين هما أثناء تخشب النواة (2، 8 مايو خلال عامي 2008،2007 على الترتيب) او عند تلوين 15-20% من الثمار(23، 16 مايو خلال عامي 2008،2007 على الترتيب)، وقد تم تتبع منحنى نمو الثمار على فترات اسبوعية بعد العقد وكذلك عقب المعاملة باسبوع حتى اكتمال النمو خاصة صفات حجم الثمار وقطرها ووزنها. وفى هذة الدراسة تم تتبع تحورات منحنى النمو لتحديد اثر المعاملات خاصة على صفتى حجم الثمرة ووزنها. ووجد ان الثمار قد اتبعت منحنى نمو زيجمودى مزدوج وكان التاثير الملحوظ لتحور هذا المنحنى بعد اجراء المعاملات ناتجا من استخدام حمض الاوليك فى مرحلة تخشب النواة خاصة فى اخر اسبوعين قبل القطف، بينما لم تؤثر باقى المعاملات بشكل يستحق الاعتبار على هذا المنحنى، كما وجد ان كل المعاملات غير مؤثرة على تحوير منحنى نمو الثمرة عندما تمت المعاملات عند بداية تلوين الثمار (15-20 % تلوين للثمرة)، كما تم تقييم تاثير المعاملات على حياة الثمار على الارفف بعد القطف مما يشابة ظروف التسويق على درجة (22 ± 2 م).

وفي نهاية فترة اختبار حياة الثمار بعد القطف Shelf life أدت المعاملة بالاثيفون بمفردة أو في وجود كل من كلوريد الكالسيوم وحمض الاوليك عند مرحلة تصلب النواة إلى زيادة محتوى الثمار من الكاروتينات، السكريات المختزلة، و نسبة المواد الصلبة الذائبة إلى الحموضة، كما أدت إلى تقليل كلوروفيل ا، كلوروفيل ب، والحموضة، كما أدى خلط كلوريد الكالسيوم مع الاثيفون إلى تأثير غير ثابت الاتجاة على فقد الوزن ، وصلابة أنسجة لحم الثمار.كما لم تؤثر تركيبة حمض الاوليك مع الاثيفون بطريقة معنوية على فقد الوزن او فقد صلابة أنسجة لحم الثمار مقارنة بالكنترول، وعلى الجانب الأخر، أدت المعاملة بحمض الاوليك بتركيز 400 جزء في المليون إلى تقليل فقد الوزن ، كلوروفيل ا ،كلوروفيل ب، كما أدت إلى زيادة محتوى الثمار من الكاروتينات، و نسبة المواد الصلبة الذائبة إلى الحموضة. بينما لم تؤثر معنويا على صلابة أنسجة لحم الثمار، السكريات الكلية، السكريات المختزلة، والسكريات غير المختزلة مقارنة بالكنترول، كما وجد انة في نهاية فترة اختبار حياة الثمار بعد القطف Shelf life أدت المعاملة بالاثيفون بمفردة أو في وجود كل من كلوريد الكالسيوم اوحمض الاوليك عند تلوين 15-20% من الثمار إلى زيادة محتوى الثمار من الكاروتينات، السكريات المختزلة ، و نسبة المواد الصلبة الذائبة إلى الحموضة، كما قللت الحموضة. بينما لم تؤثر معنويا على فقد الوزن، وصلابة أنسجة لحم الثمار، كلوروفيل ا ، كلوروفيل ب، والسكريات غير المختزلة. كذلك أدت معاملة الاثيفون بمفردة إلى زيادة فقد الوزن وخفض صلابة أنسجة لحم الثمار، مقارنة بالكنترول. لكن المعاملة بحمض الاوليك بتركيز 400 جزء في المليون ادت إلى زيادة محتوى الثمار من الكاروتينويدات ، السكريات المختزلة ، نسبة المواد الصلبة الذائبة إلى الحموضة ونقص الحموضة. بينما لم تؤثر معنويا على فقد الوزن ، وصلابة أنسجة لحم الثمار، كلوروفيل ا ، كلوروفيل ب،السكريات الكلية و السكريات غير المختزلة مقارنة بالكنترول، وقد اثبتت هذة الدراسة اهمية دور حمض الاوليك فى منع او تخفيف التاثير الضار للاثيفون على صلابة انسجة ثمرة المشمش، بينما كان استخدام حمض الاوليك بمفردة قادر على تحسين صفات هامة مرغوبة للثمرة مثل محتوى الكاروتينويدات وزيادة نسبة المواد الصلبة الذائبة للحموضة.

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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.

Treatment	Weight loss %		Firmness (Newton)		chlorophyll a (mg/L)		chlorophyll b (mg/L)		Carotene (mg/100 gm)		Total Sugars %		Reduceing sugars %		Non-reducing Sugars %		TSS%		Acidity %		TSS/Acidity%	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Control	14.106 b	14.862 a	28.54 c	29.164 b	0.123 a	0.117 a	0.022 b	0.025 a	2.423 d	2.458 d	7.081 cd	7.583 c	0.601 cd	0.504 cd	6.480 c	7.079 c	14 d	14.2 bc	0.701 a	0.737 a	19.999 d	19.419 b
Ethephon 200ppm	17.978 a	16.190 a	19.393 d	17.629 c	0.069 c	0.065 c	0.013 c	0.007 c	4.499 a	4.636 a	9.105 a	9.606 a	0.805 ab	0.701 ab	8.300 a	8.905 a	16.5 ab	15.8 a	0.254 e	0.549 b	64.795 a	28.723 a
$CaCl_2$ 2%	10.595 d	11.644 b	43.97 a	47.416 a	0.101 b	0.095 b	0.021 b	0.020 ab	2.641 c	2.668 c	6.818 d	7.318 c	0.504 d	0.409 d	6.314 c	6.909 c	14.4 cd	13.8 c	0.549 b	0.638 ab	26.224 cd	22.981 ab
Oleic acid 400 ppm	10.782 cd	12.149 b	31.329 bc	31.877 b	0.064 c	0.056 c	0.015 c	0.008 c	3.977 b	4.125 b	7.513 cd	8.013 bc	0.701 bc	0.601 bc	6.812 bc	7.412 bc	15 cd	15.6 a	0.469 b	0.612 ab	32.01 c	25.601 ab
Ethephon 200 ppm + $CaCl_2$ 2%	12.120 c	13.058 b	37.081 b	36.132 b	0.077 c	0.071 c	0.013 c	0.012 bc	4.097 b	4.123 b	7.648 bc	8.253 bc	0.736 b	0.635 b	6.912 bc	7.618 bc	17 a	15.4 ab	0.393 d	0.531 b	43.620 b	29.102 a
Ethephon 200 ppm + Oleic acid 400 ppm	14.264 b	15.275 a	30.261 c	30.61 b	0.068 c	0.058 c	0.013 c	0.014 bc	4.019 b	4.053 b	8.398 ab	8.898 ab	0.875 a	0.770 a	7.522 ab	8.128 ab	15.6 bc	15.2 ab	0.370 d	0.531 b	42.405 b	28.613 a

*Values, within a column, of similar letters are not significantly different according to the least significant difference (LSD) at 0.05 levels.
*Newton=Ib/in^2 × 4.448.

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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.

Treatment	Weight loss %		Firmness (Newton)		chlorophyll a (mg/L)		chlorophyll b (mg/L)		Carotene (mg/100 gm)		Total Sugars %		Reduced sugars %		Non-reducing Sugars %		TSS%		Acidity %		TSS/Acidity%	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Control	13.801 b	13.540 bc	34.042 bc	29.609 b	0.138 a	0.130 a	0.030 a	0.023 ab	2.022 d	2.059 d	6.859 b	6.870 ab	0.504 c	0.472 c	6.371 ab	7.342 ab	14 b	13.6 c	0.701 a	0.745 a	19.999 d	18.337 c
Ethephon 200 ppm	17.315 a	16.040 a	27.118 d	19.349 c	0.058 b	0.049 b	0.014 b	0.011 b	3.565 a	3.597 a	8.168 a	7.933 a	0.735 a	0.735 a	7.933 a	8.668 a	16.6 a	15.2 a	0.390 d	0.576 c	42.627 a	25.643 a
$CaCl_2$ 2%	11.758 b	12.192 bc	48.720 a	55.170 a	0.119 a	0.111 a	0.027 ab	0.024 ab	2.020 d	2.052 d	5.986 b	6.043 b	0.440 c	0.440 c	5.546 b	6.483 b	14.6 b	13.6 c	0.612 b	0.737 ab	23.859 d	18.685 bc
Oleic acid 400 ppm	12.93 b	11.516 c	36.311 b	29.016 b	0.103 ab	0.095 ab	0.035 a	0.028 a	3.006 bc	3.042 bc	6.128 b	5.663 b	0.667 ab	0.667 ab	5.960 b	6.328 b	15.2 ab	14.4 bc	0.513 d	0.638 bc	29.620 c	22.620 ab
Ethephon 200 ppm + $CaCl_2$ 2%	12.386 b	12.098 bc	37.823 b	36.681 b	0.101 ab	0.092 ab	0.029 a	0.021 ab	2.652 c	2.688 c	6.853 b	6.75 ab	0.601 b	0.601 b	6.252 ab	7.346 ab	14.2 b	15.1 ab	0.407 d	0.589 c	34.836 b	25.670 a
Ethephon 200 ppm + Oleic acid 400 ppm	13.449 b	13.976 ab	30.4.84 cd	20.905 c	0.110 ab	0.080 ab	0.027 ab	0.019 ab	3.231 ab	3.267 ab	8.108 a	7.824 a	0.634 b	0.634 b	7.474 a	8.458 a	14.4 b	15.3 a	0.369 d	0.598 c	39.785 a	25.643 a

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

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