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EFFECT OF PUTRESCINE, GIBBERELLIC ACID AND CALCIUM ON QUALITY CHARACTERISTICS AND MATURITY DELAY OF "DESERT RED" PEACH FRUIT CULTIVAR.
B: CHEMICAL PROPERTIES OF THE FRUIT.

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ABSTRACT

This study was conducted during two successive seasons 2005 and 2006 by using "Desert Red" peach cultivar (*Prunus persica L.*) grafted on Nemaguard rootstock. Trees were sprayed with a hand sprayer to the run off at the initiation of phase III of the double sigmoid curve before the onset of the climacteric. The treatments included putrescine at 5 and 10 mM, GA_3 at 200 and 400 ppm, in addition to each of the above treatments plus calcium chloride (at 2%, w/v), $CaCl_2$ alone, and the control (water spray). The surfactant tween-80 was added to all treatments at 0.05% (v/v). Skin of putrescine-treated fruits contained higher amount of chlorophyll a than the control. In a similar manner, both GA_3 concentrations resulted in higher content of chlorophyll a especially in the first season. Moreover, $CaCl_2$ treatment did not cause a significant change in chlorophyll a in both seasons. Putrescine at 5 or 10 mM, and $CaCl_2$ did not result in a significant change in carotene content, while GA_3 at 200 ppm caused a reduction in carotenes as compared with the control. Various used putrescine and GA_3 concentrations caused a significant reduction in anthocyanin content as compared with the control in both seasons. Similarly, $CaCl_2$ alone was able to significantly reduce anthocyanin content in fruit skin while its addition to any of putrescine or GA_3 treatments did not,

generally, caused a significant alteration in anthocyanin content. Putrescine at 10 mM consistently reduced TSS/ acidity ratio as compared with the control. While, GA_3 in general, tended to reduce such ratio when compared with the control. Meanwhile, $CaCl_2$ did not result in a significant change in TSS to acidity ratio in both seasons. Combing $CaCl_2$ with each of putrescine or GA_3 concentrations did not result in added advantage in terms of inducing further reduction of deteriming pigments or sugars. This study recommended spraying GA_3 at 200 ppm or putrescine at 10 mM (882ppm) or calcium chloride at [2% (w/v), 20,000 ppm] to delay "Desert Red" peach fruit maturity by, at least one week provided that treatments must be applied at the beginning of the third phase of the double sigmoid curve.

INTRODUCTION

Peaches are highly demanded by Egyptian consumers. To prolong the time of peach marketing which reflects on increasing the growers profits, many new cultivars have been cultivated in Egypt. Moreover, breaking dormancy early in spring by some agents such as Dormix and some cultural practices extended the period of peach harvest. Meanwhile, most of the new cultivars reach to maturity in mid season which increases the supply and lowers prices. Peach fruits are also known with their short shelf life and weak storability. Consequently, many fruit are lost which forces peach producers to harvest their fruits at minimum maturity. Peach fruits at such stage lack the desired flavor and aroma. Peach was classified into climacteric fruit ripening. In peach, the rise in ethylene production regulates the ripening process (Kende, 1993; Leliever *et al*, 1997; Mathooko *et al.*, 2001). However, the climacteric ethylene in peach is an event occurring late when the fruit has already consistently softened (Tonutti *et al.*, 1997). For this reason, peach fruits exhibit short storage life that limit their commercial potential and induce farmers to anticipate the harvest date. As a negative consequence for this excessive early harvest, the overall peach fruit quality is reduced and does not fulfill the consumer's expectation. Aforementioned, there are great need treatments that delay fruit maturity and ripening of

peaches and to extend the shelf life of such fruits. To reach this goal and improve fruit quality, substances able to interfere with ethylene biosynthesis would manipulate peach fruit ripening. Polyamines such as "putrescine", gibberellic acid and calcium play important roles in the life of fruits and could have the potential to achieve the desired goals. Polyamines are well- known regulators of growth and differentiation (Bagni and Torrigini, 1992), and compete directly with ethylene for their common precursor S-adenosy-L-methionine (SAM) (Valero *et al.*, 2002, b). Whereas the high calcium content in fruit tissues has been shown to reduce disorders (Sharples & Johnson, 1977), retard softening and inhibit decay of apples (Conway *et al.*, 1991). In addition to strengthening cell walls and membranes, calcium also regulates some physiological processes that may directly or indirectly affect the quality of fruit (Poovaiah, 1988). Gibberellic acid was found to delay ripening and senescence of fruits, as well as fruit maturity in peaches (Sher-Muhammad *et al.*, 1996, a). Thus, the objectives of this research were to delay fruit maturity and ripening of "Desert Red" peach fruits by using safe means that could adopted by growers without sacrificing the quality. Such delay would reduce the supply of mid-season peaches which benefits peach producers.

MATERIALS AND METHODS

The study was conducted during two successive seasons 2005 and 2006 on "Desert Red" peach cultivar (*Prunus persica L.*) budded on Nemaguard peach rootstock and grown in Nubaria region, Beheira governorate, Egypt. Trees were healthy, uniform and free of defects. The orchard trees were maintained under the standard cultural practices commonly adopted for this area. The soil was sandy, well drained and the depth of water table was at least at two meters and the trees were under dripping irrigation system. Trees were on 5-year-old trees and trained to open-vase shape. Trees were sprayed to the run off using a hand sprayer on 17, 20 April during 2005 and 2006, respectively. Treatments included water as the control, Putrescine [1, 4-Diaminobutane($C_4H_2N_2$)] at 5 mM (441 ppm)or 10 mM (882 ppm), GA_3 at 200 or 400 ppm in addition to each of the above treatments plus $CaCl_2$ at 2% (w/v) and finally $CaCl_2$ alone at 2% (w/v). The non-ionic surfactant Tween 80 at 0.05% (v/v) was added to all treatments to reduce the surface tension and increase the

contact angle of sprayed droplets. The treatments were sprayed at the initiation of the double sigmoid curve (before the onset of climacteric ethylene). The study treatments were arranged in a factorial experiment in randomized complete block design. Four replications were used per each treatment. Thus forty trees were employed where each tree represented one replication. The percentage of total soluble solids (T.S.S %) in fruit juice was measured using a hand-refractometer. The acidity was colorimetrical 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). Total sugars were determined by using the phenol sulfuric acid method (Smith, 1956), Reduced sugars were determined according to the Lane and Eynon method as described by (Egan *et al.*, 1981). Chlorophyll A; B and Beta-Carotene were determined according to (Wintermans and Mats, 1965). To describe, the procedure briefly: half gram of fresh peel from the green cheek was extracted by about 15ml of 85% acetone and 0.5g calcium carbonate, the mixture was filtered through a glass funnel and the residue was washed with a small volume of acetone and completed to 25 ml. The optical density of a constant volume of filtrate was measured at a wave length of 662 nm, for chlorophyll A, 644 nm, for chlorophyll B and 440 nm, for Carotene using spectrophotometer. Anthocyanin was determined according to the method of Fuleki and Francis (1968) as follow: 10 grams of fresh peel from color cheek, was extracted by using 20 ml of the extraction solution (85% ethyl alcohol 95% + 15% HCL 1.5N), the mixture was left for the extraction of anthocyanin for 2 weeks, 1 ml of the filterate was used to determine the optical density of for 535 nm, after adding 5 ml of the extraction solution. The blank was just the used extraction solution, using spectrophotometer. The analysis of variance was obtained by using SAS computer (2000) software. While comparisons among means were made via the Least Significant Differences multiple ranges according to Snedecor and Cochran (1972). The data were analyzed using SAS (2000) program.

RESULTS & DISCUSSIONS

II. The Treatment Factor regardless the time:

1. Chlorophyll a Content:

Data of chlorophyll a content as influenced by various treatments was shown in Table 1. it was indicated that chlorophyll a in putrescine-treated fruits was significantly higher than that of the control. Even in the second season, putrescine-treated peaches tended to have higher chlorophyll a values than that of the control. In a similar way, the formation of chlorophyll a in GA_3-treated fruits was similar to the found with putrescine in terms of the amount of chlorophyll a. the application of calcium chloride did not result in a significant change in chlorophyll a. when the combination of putrescine (at 5 or 10 mM) plus calcium was compared with that of putrescine alone, no added advantage was obtained due to the presence of calcium in that aspect. Similarly, GA_3 plus calcium caused the formation of chlorophyll a similar to that obtained with only GA_3 application in both seasons, whether GA_3 was used at 200 or 400 ppm. In general, most treatments did not significantly increase chlorophyll a in the peach fruit skin as compared with the control. Aforementioned findings agreed with the results of Evans and Malmberg (1989) reported that, polyamines were effective as anti-senescence agent and found to retard chlorophyll loss, membrane deterioration and increase in RNase and protease activity. Sher-Mohammed *et al* (1997) reported that, the GA_3 sprays significantly delayed the development of yellow color on the "Redhaven" peach fruit.

2. Chlorophyll b Content:

With regard to the influence of various treatments on the content of chlorophyll b in fruit skin was shown in Table 1, it was found that putrescine treatments did not cause a significant change in chlorophyll b when compared with the control except in the case of putrescine at 10 mM in the first season. The applications of GA_3 at 200 or 400 ppm were not effective in retarding the loss of chlorophyll b in fruit skin in both seasons. Furthermore, calcium chloride treatment was not able to significantly retard the loss of chlorophyll b in peach skin. Even the combination of putrescine, at either used

(Table 1) Chemical characteristics of "Desert Red" Peach fruits as influenced by various used treatments, regardless the Time, during the two seasons 2005 and 2006

Treatment	chlorophyll a (mg/L)		chlorophyll b (mg/L)		Carotene (mg/100gm)		Anthocyanin (mg/L)		Total Sugars %		Reduced sugars %		Non-reducing Sugars %		TSS%		Acidity %		TSS/Acidity%	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Control	0.293 d	0.326 h	0.141 c	0.183 a	0.875 a	0.924 a	5.094 a	5.430 a	5.757 a	5.778 ab	0.846 bcd	0.103 a	4.910 a	4.74 ab	7.320 a	8.400 ab	0.624 bc	0.713 b	11.890 ab	12.090 a
Putrescine Sol1	0.340 ab	0.349 ab	0.164 abc	0.200 a	0.876 a	0.914 a	3.384 c	3.472 de	5.604 b	5.643 bcde	0.794 cd	0.971 a	4.80 a	4.67 bc	7.190 ab	8.310 abc	0.656 bc	0.714 b	11.174 bcd	12.004 ab
Putrescine 10mM	0.148 a	0.345 ab	0.177 a	0.302 a	0.859 ab	0.897 abc	3.463 c	3.409 e	5.722 ab	5.599 cde	0.853 bcd	0.991 a	4.86 a	4.60 cb	7.230 ab	8.130 cd	0.670 a	0.727 ab	11.099 cd	11.617 bcde
GA3 20ppm	0.318 bcd	0.341 ab	0.149 bc	0.206 a	0.769 b	0.811 bc	3.524 c	3.668 cde	5.696 ab	5.588 cde	0.783 d	1.002 a	4.91 a	4.58 cb	7.020 ab	8.220 bcd	0.667 a	0.736 a	10.666 d	11.564 cde
GA3 40ppm	0.326 abc	0.326 b	0.166 abc	0.189 a	0.770 b	0.809 c	3.562 c	3.511 de	5.762 a	5.480 c	0.841 bcd	1.003 a	4.92 a	4.47 c	7.170 ab	8.190 cd	0.656 ab	0.738 a	11.245 bcd	11.553 de
Putrescine 5mM + GA3 20ppm	0.336 abc	0.364 a	0.157 abc	0.194 a	0.872 a	0.913 a	3.416 c	3.783 cd	5.731 a	5.537 de	0.864 bc	0.982 a	4.86 a	4.55 cb	7.290 a	8.250 bcd	0.638 abc	0.710 b	11.567 abc	11.979 abc
Putrescine 10mM + GA3 20ppm	0.342 ab	0.374 a	0.159 abc	0.209 a	0.879 a	0.917 a	3.452 c	3.854 c	5.786 a	5.840 a	0.894 ab	0.960 a	4.89 a	4.88 a	7.290 a	8.190 cd	0.635 abc	0.727 ab	11.607 abc	11.697 abcde
GA3 200ppm + GA3 2%	0.144 ab	0.341 ab	0.169 ab	0.194 a	0.842 ab	0.885 abc	3.555 c	3.906 c	5.723 a	5.687 abcd	0.911 ab	1.019 a	4.82 a	4.66 cb	7.050 b	8.190 cd	0.600 c	0.727 ab	11.919 ab	11.651 bcde
GA3 400ppm + GA3 2%	0.324 abc	0.343 ab	0.156 abc	0.191 a	0.888 a	0.930 a	3.594 bc	3.764 cd	5.806 a	5.660 bcd	0.960 a	0.994 a	4.84 a	4.66 cb	7.350 a	8.100 d	0.622 bc	0.740 a	12.154 a	11.445 c
GA3 2%	0.310 cd	0.328 b	0.154 abc	0.188 a	0.855 ab	0.906 ab	3.846 b	4.547 b	5.697 ab	5.730 abc	0.889 ab	0.985 a	4.80 a	4.74 ab	7.290 a	8.160 a	0.621 bc	0.741 a	11.824 abc	11.857 abcd

Values, within a column, of similar letters, were not significantly different according to the least significant difference (L.SD) at 0.05 level.

concentrations, plus calcium did not significantly vary in their effect on chlorophyll b as compared with that of putrescine in both seasons. In a similar pattern, no added advantage was obtained as a result of incorporating calcium with GA_3 (at either 200 or 400 ppm) with regard to chlorophyll b content in "Desert Red" peaches. In peach fruits, the rate of chlorophyll b degradation was faster than that of chlorophyll a when changes of this pigment were followed after fruit set to maturity (Gross, 1987).

In putrescine, as anti-ethylene compound, and GA_3 could have retarded the loss of chlorophylls if applied earlier in the season which explained the non-significant influenced of such compound on chlorophyll b in peaches(Abdel-Gawad and Romani, 1974).

3. Carotene Contents:

Data of carotene content in "Desert Red" peaches at harvest as influenced by various treatments were shown in Table 1. The data revealed that putrescine treatment either at 5 or 10 mM did not significantly alter carotene content in the fruit at harvest as compared with the control. Moreover, both used putrescine concentrations were equally effective on carotenes in the fruit. However, GA_3 applications at 200 and 400 ppm were able to significantly reduce carotene in both seasons when compared with the control. The increase in GA_3 to 400 ppm did not have an additional influence on carotenes as compared with applying GA_3 at 200 ppm and that trend was consistent in both seasons.

On the other hand, $CaCl_2$ treatment did not lead to a significant change in carotenes relative to the control in both seasons. There was no added advantage from the incorporation of $CaCl_2$ with both putrescine concentrations when compared with just using putrescine alone in terms of their influence on carotenes in both seasons. Meanwhile, GA_3 application at 400 ppm in the presence of $CaCl_2$ resulted in higher carotene content than that obtained with GA_3 alone at the same concentration in both seasons. When GA_3 concentration at 200 ppm was applied plus $CaCl_2$, further advantage was gained when carotenes in the fruit were compared with the use of GA_3 at 200 ppm alone.

Since carotenes are formed early in the fruit life and masked by chlorophylls and the treatments were done by the beginning of the third phase of the double sigmoid curve, various treatments were not

effective on altering carotenes except with GA_3 concentrations. That trended to delay the maturity processes it was reported that gibberellins retard the conversion of chloroplasts to chromoplasts (Gross., 1987) which agreed with above finding. However, ethylene enhances such conversion (Ben-Arieh and Guelfat-Reich., 1975). Since putrescine is an anti-ethylene compound, It was expected that putrescine would significantly reduce carotenes at harvest. The treatment effect shown in Table was the summation of four weeks following the application.

4. Anthocyanin Contents:

The effect of various treatments on anthocyanin formation in "Desert Red" peaches was reported in Table 1 and illustrated in Photo 1. The results indicated that putrescine treatments led to a significant reduction in anthocyanin content in peach skins whether at 5 or 10 mM as compared with the control. However, the increase in putrescine concentration from 5 to 10 mM did not make a difference in anthocyanin content in both seasons. Retardation of anthocyanin formation was also found by GA_3 applications at 200 or 400 ppm. Increasing GA_3 concentration did not also further decrease anthocyanin in fruit skin. It was also noticeable that the efficacy of putrescine on reducing anthocyanin formation was statistically similar to that obtained with GA_3 concentrations in a consistent manner.

The application of calcium chloride was also able to delay the formation of anthocyanin in peach skin in a significant way when compared with the control. Thus, the control fruits were advanced in anthocyanin formation in the peach fruit cheeks. when compared with all used treatments. The presence of calcium along with putrescine did not make a significant difference in anthocyanin content when compared with just using putrescine alone in both seasons except with putrescine (at 10 mM) plus calcium in the second seasons. When a similar comparison was made between the combination of GA_3 plus calcium and just GA_3 alone, no remarkable change in anthocyanin formation was found in fruit skins. As a general conclusion, no additional advantage was obtained when $CaCl_2$ was combined with either putrescine or GA_3 with regard to anthocyanin formation.

Hence, it could be concluded that each of putrescine, GA_3 or calcium chloride had the ability to delay peach fruit maturity and ripening since anthocyanin formation and intensity are major

attributes or criteria for these stages. Trends obtained in this study as a result of using various treatments to retard anthocyanin formation agreed to these found by several authors that reported the beneficial effects of polyamines, such as putrescine to delay color changes and increase shelf life, for both climacteric and non climacteric fruits. Furthermore, Valero *et al.*, (1999) reported the physiological roles of polyamines these compounds in their free forms play critical roles as anti-senescence agents, from both endogenous and exogenous application, the main effects in fruit being retarded color changes, increase fruit firmness, delayed ethylene and respiration rate emission and induced mechanical resistance. Saure (1990) who reported that, anthocyanin formation may be promoted either directly by reducing GA activity, or in directly by increasing the level of ethylene and/or ABA, which are GA antagonists. The above mentioned results were in agreement with these previously reported by many investigator such as Factaeu *et al* (1985), Sher-Mohammed *et al* (1997). On the other hand, Ochei *et al* (1993) reported that, calcium treatment, delayed fruit ripening in Surecrop peach trees.

5.Total Sugars:

Results of total sugars in peach fruit tissue as influenced by various treatments were reported in Table 1. Quantitatively, a slight change occurred in total sugars as a result of putrescine treatments, but, generally, the trend toward the reduction of total sugars as compared with the control was not consistent between the two seasons. Similarly, GA_3 applications at 200 or 400 ppm resulted in a significant reduction of total sugars only in the second season. Even in the case of calcium chloride treatment, no significant change in total sugars was found when compared with the control. Thus, no specific pattern in total sugars was obtained as a result of putrescine or GA_3 applications. The addition of calcium to putrescine at 10 mM led to a significant increase in total sugars in both seasons as compared with putrescine alone at 5 mM but only higher than that value of total sugars obtained with putrescine (10 mM) in the second season. On the other hand, the combination of GA_3 plus calcium at both used concentrations did not result in a considerable change in total sugars as compared with using GA_3 alone. Hence, no further change was obtained in total sugars, in general, as a result of incorporating calcium with either GA_3 or putrescine. Aforementioned data agreed

with the reported results of Lee-ChongSuk *et al* (2000) who reported that, GA_3 tended to reduce the concentration of sucrose and glucose.

6. Reducing Sugars:

Fruit content of reducing sugars as influenced by various treatments was reported in table 2. The data indicated that putrescine whether at 5 or 10 mM did not significantly affect such sugars when compared with the control in both seasons. There was even no significant difference between reducing sugar contents when comparing the influence of putrescine at 5 and 10 mM. Moreover, the control fruits contained a similar amount of reducing sugars to that obtained with GA_3 at 200 or 400 ppm in both seasons. In addition, putrescine at both concentrations did not result in a significant difference in the amount of reducing sugars when compared with GA_3 at 200 or 400 ppm. The application of calcium chloride did not result in any appreciated difference when compared with the control in both seasons. The presence of calcium along with putrescine did not make a difference in reducing sugar contents when compared with the use of putrescine alone at similar concentration. On the other hand, combining calcium to GA_3 as compared with GA_3 alone (at 200 or 400 ppm) did not result in a consistent trend of reducing sugars content in both seasons. Thus, calcium presence along with either putrescine or gibberellic acid did not much to the amount of reducing sugars in "Desert Red" peaches in this study. Since sucrose is the dominant sugar in peach fruits, this might explain the non remarkable changes in reducing sugars in this peach cultivar. Such findings were in line with Martin et al., (1971), Srivastava et al., (1974).

7. Non-reducing Sugar:

The data concerning the effect of various treatments, regardless the time, on non-reducing sugars was reported in table 2. The data revealed that all used treatments did not cause a significant change in non-reducing sugars compared with the control in the first season. In the second season, in a similar manner, almost all treatment, except GA_3 at 400 ppm, were not able to cause a significant difference in such sugars. Furthermore, the combination of GA_3 at 200 ppm plus calcium did not vary from the effect of GA_3 alone at the same concentration in terms of their effect on non-reducing sugars. Similarly, GA_3 at 400 ppm gave the same above trend. On the other hand, putrescine at 5 mM in the presence or absence of calcium did

(Table 2) Chemical characteristics of "Desert Red" Peach fruits throughout the period following treatments during the two seasons 2005 and 2006:

Time*	chlorophyll a (mg/L)		chlorophyll b (mg/L)		Carotene (mg/L)		Anthocyanin (Mg/L)		Total sugars %		Reduced sugars %		Non-Reducing sugars %		TSS%		Acidity %		TSS/Acidity%	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Second week	0.410** b	0.368 b	0.132 b	0.215 b	0.898 a	0.898 b	3.261 c	4.049 b	5.381 c	5.354 c	1.225 b	1.664 a	4.15 c	3.68 d	6.915 d	8.265 c	0.621 c	0.565 c	11.300 b	14.635 a
Third week	0.185 cd	0.218 c	0.113 cd	0.144 c	0.828 b	0.846 bc	3.498 b	3.236 d	5.523 b	5.497 b	1.320 a	1.248 b	4.20 c	4.24 c	7.200 c	8.340 c	0.708 a	0.862 a	10.364 c	9.718 d
Fourth week	0.192 c	0.212 c	0.122 c	0.130 c	0.757 c	0.832 c	3.647 b	3.721 c	5.481 b	5.465 bc	0.406 d	0.473 c	5.07 b	4.99 b	7.930 a	8.835 a	0.709 a	0.863 a	11.220 b	10.246 c
Fifth week	0.164 d	0.182 d	0.102 d	0.110 d	0.911 a	0.987 a	4.749 a	5.106 a	7.267 a	7.281 a	0.245 e	0.340 d	7.02 a	6.94 a	7.560 b	8.595 b	0.657 b	0.821 b	11.572 b	10.464 c

* Time mentioned in this table indicated to the sampling time after applying the treatments.

** Values, within a column, of similar letters were not significantly different according to the leact significant difference (LSD) at 0.05 level.

not result in a significant difference in such sugars. However, putrescine at 10 mM. in the second season, plus calcium caused a significant increase in non-reducing sugars when compared with putrescine alone at the same concentration. In general, no appreciated change occurred in non-reducing sugars as a total effect of the treatments by the end of the experiment.

8. Total Soluble Solids:

Data of total soluble solids as influenced by various treatments to "Desert Red" peach fruits was reported in table 2. The data revealed that putrescine at 5mM was not effective in changing TSS content in the fruit in both seasons. A slight reduction in TSS occurred by putrescine at 10 mM but only was significant at the second season. Moreover, the application of GA_3 did not result in a consistent reduction in TSS content as compared with the control in both seasons.

Furthermore, the control fruits did not significantly vary from those treated with calcium chloride in both seasons. It was found that there was no significant difference between the efficacy of putrescine and GA_3 at all used concentrations in terms of the content of TSS in both seasons. The incorporation of calcium with putrescine at 5 or 10 mM did not significantly affect TSS values when compared with those resulting from putrescine alone. The use of GA_3 at 200 ppm in the presence or absence of calcium did not cause a significant effect on TSS values. In a similar manner there was no added advantage on TSS content when GA_3 at 400 ppm plus calcium was compared with just GA_3 at the same concentration in both seasons. However, a significant reduction in TSS occurred in both seasons when peaches were treated with the combination of GA_3 at 200 ppm plus calcium as compared with the control.

The above findings agreed with those found by the studies of Torrgiani *et al* (2004) reported that, low TSS and high acidity levels are typical of fruits which are reaching the full ripening and the substances may have delay the progress of the ripening process as compared to control. Facteau (1985) reported that, preharvest treatment with GA_3 at 10ppm 21 day before harvest significantly increased TSS content of fruit compared with control. These results are in agreement with findings of several authors such as Amarante et al (2005) reported that, GA_3 reduced the TSS content in fruits.

Moreover, Dirs and Niskaken (1999) reported that, $CaCl_2$ resulted in decrease TSS content compared with control.

9. Juice Acidity:

Responses of juice acidity of "Desert Red" peach fruits to various treatments were shown in table 2. The data indicated to a general trend of increase juice acidity as a result of putrescine treatments at both concentrations when compared with the control. However, such increase was not significant except with putrescine at 10 mM in the first season. Application of GA_3 at 200 ppm was able to significantly increase fruit acidity in both seasons.

Similar trend of results was found with GA_3 treatment at 400 ppm except with GA_3 at 400 ppm in the first season. In general, there was no significant difference between juice acidity of putrescine-treated fruits and those treated with GA_3. On the other hand, calcium chloride treatment did not result in a consistent change in juice acidity relative to control.

The addition of calcium to each putrescine concentrations did not make a considerable difference when juice acidity was compared with thise treated with putrescine alone. The combination of GA_3 concentrations plus calcium as compared with the effect of GA_3 alone in terms of their influence on juice acidity did not significantly make a difference except with GA_3 at 200 ppm plus calcium in first seasons that resulted in lower acidity than GA_3 (at 200 ppm) alone.

The found results in this study agreed with these found in previous research such as Torrgiani *et al* (2004) reported that, high acidity levels are typical of fruits which are reaching the full ripening and the substances may have delay the progress of the ripening process as compared to control. Similar observations were found by Zilka *et al* (1997), Lee-Chong Suk *et al* (2000), Amarante *et al* (2005) they reported that, titralable acidity of GA_3-treated fruit was significantly higher than that of untreated fruit. While Ochie *et al* (1993) reported that, $CaCl_2$ sprays generally increased titralable acidity compared with control. Contradictory, El-Sheikh-Ali *et al* (1998) reported that, preharvest treatment with $CaCl_2$ resulted in reduced titralable acidity in LeConte pear fruit.

10. Fruit TSS/Acidity Ratio:

With regard to the changes in TSS/acidity in the juice of "Desert Red" peach fruits as result of various treatments (table 2), the

data showed that putrescine at 5 mM was not significantly effective in changing such ratio. However, putrescine at 10 mM resulted in a significant reduction in TSS to acidity in both seasons as compared with the control. In a similar manner, GA_3 at 200 ppm was able to reduce the ratio of TSS to acidity in a consistent pattern. Application of GA_3 at 400 ppm to peach fruits also tended to reduce such ratio. Meanwhile, calcium chloride treatment, regardless the time factor, was not effective in reducing TSS/acidity in fruit tissue. The combination of putrescine plus calcium whether at 5 or 10 mM of putrescine did not result in a significant difference in TSS to acidity ratio. Furthermore, GA_3 at 200 or 400 ppm in the presence of calcium chloride not significant vary in their influenced on TSS to acidity ratio. The effectiveness of putrescine at 5 mM on TSS/acidity did not considerably change when compared with its combination with calcium. Again putrescine efficacy at 10 mM on TSS/acidity was similar to that found with its combination with calcium in both seasons. Aforementioned results were supported by the results of previous studies such as Torrgiani *et al* (2004) reported that, all the concentration of polyamines (putrescine and spermidine) and application times tested. reduced the SSC/acidity ratio as compared to control, mainly. On the other hand, Dris and Niskaken (1999) reported that, $CaCl_2$ decreased the TSS/acidity ratio compared with control.

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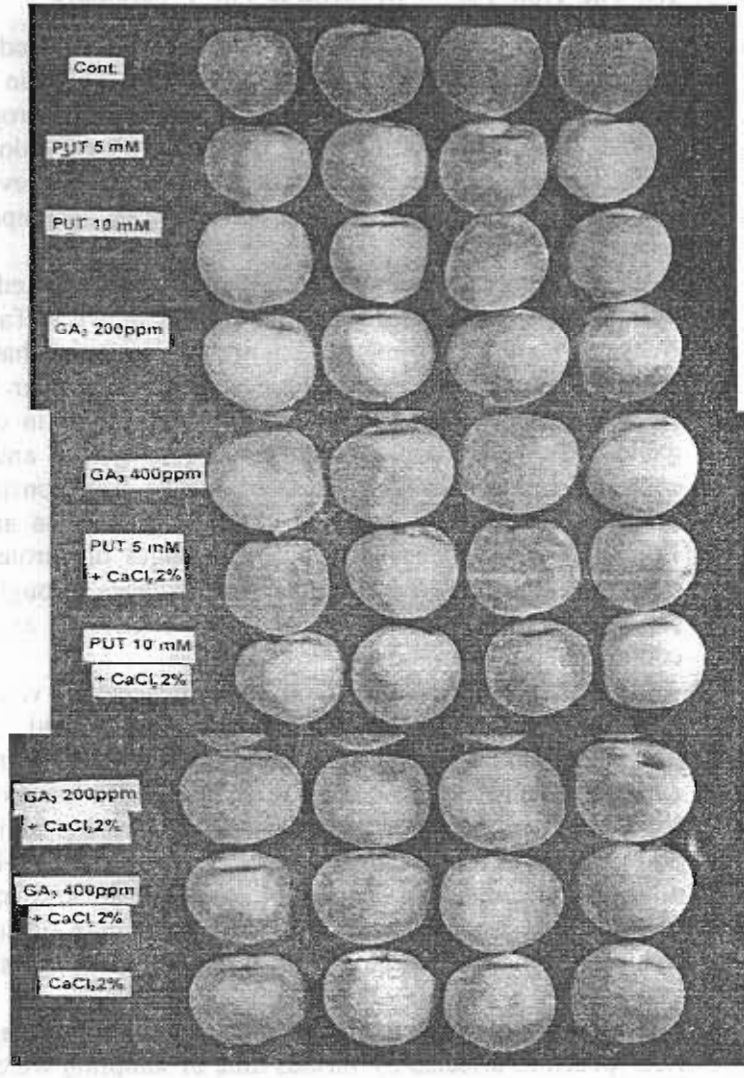

Photo 1: Variations in the exposed colored cheek of "Desert Red" peach fruits as influenced by various treatments compared with the control.

III. The Time Factor Regardless The Treatments

Changes in chlorophyll a, b in "Desert Red" peaches as influenced by various time of sampling were shown in Table 2. The data indicated that, chlorophyll a, b was lost by the progress of time, in the fifth week (at harvest) the contents of chlorophylls was significantly decreased compared with the previous weeks, respectively. The loss of chlorophylls was accompanied to the maturation changes in peach fruit.

Changes in carotene contents in "Desert Red" peaches in response to various times of sampling were shown in Table 2. After 2 weeks of applying various treatments, it was found that carotenes in the fruits tended to decrease from on week to another until the fifth week of application when a significantly increase in carotenes was gained when compared with carotene data after 3 and 4 weeks of chemical treatments. This trend of results was consistent in both seasons and agreed with the finding of (Lessertios and Moneger., 1978) who determined the seasonal changes of carotenes in peach fruits and found a gradual decline in carotenes throughout the third phase of fruit life cycle followed by an increase at maturity and continued until ripening.

Data of fruit coloration as influenced by various times of sampling were shown in Table 2. The results showed that, at harvest (the fifth week) the contents of anthocyanin was higher significantly compared with the other weeks, respectively. During the processes of fruit maturity, the chlorophylls were disappearing and anthocyanin was increase as a consequence of maturation changes which involved of the autocatalytic production of ethylene. As known, peach fruit coloration is ethylene dependent and the increase of anthocyanin in the late of phase three is stimulated by ethylene, as is chlorophylls loss.

Data of total, reducing and non reducing sugars of "Desert Red" peach as affected by various time of sampling were presented in Table 2. The data indicated that, total sugars was increased by the time, as the results shown, the fifth week (at harvest) was a significantly higher of total sugars compared with the previously weeks, respectively. In a similar trend to the above finding, the non reducing sugars were increased by time. The data shown that, fifth

week (at harvest) was a higher contents of non reducing sugars when compared with the previously weeks in the growth curve. Contradictory, reducing sugars was increased in the progress of time at the third week and second week, in two seasons, respectively, and then, it began decrease to the lower levels at harvest. As results shown, the fifth week (at harvest) was a lower contents of reducing sugars as compared with the previously weeks.

Similar observations were found by Monselise (1986) who reported that, total sugar accumulates throughout development with a surge during the final swell through the onset of maturation. Starch and dextrins steadily decline reaching a minimum in mature fruit. The greatest contribution to the sugar accumulation comes, however, from a parallel increment in the rate of photosynthesis.

Changes in carotenes in "Desert Red" peaches as influenced by various time of sampling were shown in Table 2. The data revealed that, total soluble solids was increased by time at forth week, after that, at fifth week its began decrease. The forth week was a higher of TSS contents compared with another weeks, but at harvest (fifth week) the TSS contents of peach fruits was lower than its contents in the forth week. TSS contents were increased in the progress of fruit maturation as a consequence of accumulation of sugars (non reducing sugars and pigments).

Data of juice acidity of "Desert Red" peach as affected by various sampling time were presented in Table 2. The data revealed that, juice acidity was increased and reached to a higher levels at forth week, and then began decrease. The forth week was significantly a higher levels compared with the previously weeks. At harvest (fifth week), juice acidity was lower than that in the forth week.

Similar observations were found by Charlmers and van den Ende (1975) reported that, total acidity steadily increases to a peak during stage three. This may come early or late in different varieties, independently from the time of the ripening. Ryugo and Davis (1958). reported that, Total acidity in mature fruit is directly related to the peak height and inversely related to the duration of the decline. Malic and citric acids are most important components, with malic acid levels closely paralleling titrable acidity.

Changes in the TSS to acidity ratio throughout the sampling periods following spray were shown in Table 2. The data indicated to

a decline in such ratio by reaching to the third week of spray followed by a significant increase in the fourth week of spray in both seasons. This decline in the TSS to acidity ratio might by related to the increase in fruit respiration by that time which needed more breakdown of soluble materials especially sugars. The fifth week sample indicated to a similar TSS/acidity ratio to that found in the fourth week which that peach fruits might have reached to maturity by the fourth week of spray.

IIII. The Effect of the Interaction between Treatment and Time:

1- Chlorophyll a:

Chlorophyll a content of "Desert Red" peaches as influenced by the interaction between treatments and time was recorded in Table 3. The data proved that the control fruits gradually lost chlorophyll a in a significant way from one week to another following the application date. However, after one week of spray, almost all treatments were not able to make a significant change in chlorophyll a when compared with the control. As the time progressed following spray, the content of chlorophyll a declined significantly from week one to five by all treatments in both seasons. However, even by reaching to the forth week after application, there was no significant difference in chlorophyll a between putrescine-treated fruits and the control. Similarly, results were found with to with GA_3-treated peaches. The addition of calcium chloride to either putrescine or GA_3 treatments did not result in a significant change in chlorophyll a over time after spray. Thus, the data suggested that chlorophyll a change was not a critical factor in the process of delaying peach maturity by using treatments. Moreover, by all treated peaches tended to have higher chlorophyll a content than that found in the control fruits. Thus, increase in chlorophyll a, however was not statistically significant in two seasons.

2- Chlorophyll b:

The effect of the interaction between treatments and time on chlorophyll b was shown in Table 4. The data revealed that all treatments were not effective on changing chlorophyll b by the end of first week following spray when compared with the control. The weekly decline in chlorophyll b from the first to the fifth week in the

control fruits was significant. However, such difference up to the third week following spray in most cases. By reaching to the forth week following the application putrescine treatment either at 5 or 10 mM caused a significant increase in chlorophyll b in both seasons. However, the difference in chlorophyll b between the control and putrescine (at 5 or 10 mM) in the presence of calcium chloride was not significant at the same harvesting date. Calcium chloride treatments was not able to induce a significant change in chlorophyll b whether in the forth week or fifth week of the application. In spit of the retarding effects of GA_3 to fruit ripening, but such retardation could not be attributed to chlorophyll b in this study since this trait did not change significantly by the fifth week after application. Similar conclusion was reached when GA_3 plus calcium effect on chlorophyll b was compared with that of the control after five weeks of the application in terms of chlorophyll b content.

3- Carotene Content:

After 5 weeks of applying the treatments, putrescine (at 5 or 10 mM) gained a significantly increase in carotenes as compared with control in the fourth week following the applications (Table 5). This was true with GA_3-treated fruits at 400 ppm but was not true with GA_3-treated fruits at 200 ppm. However, by the fifth week of spray, only GA_3-treated fruits at 200 ppm had significantly lower amount of carotenes than the control. Furthermore, GA_3 at 400 ppm attained a significantly decline in carotene in the fourth week as compared with the control in the fifth week in both seasons. When the data was compared earlier after 2 weeks of spray, it was found that only GA_3 (at 400 ppm) and GA_3 at 200 ppm plus $CaCl_2$ were able to significantly reduce the amount of carotene in the fruit when compared with the control after the same period of spray. The data also revealed that carotenes in putrescine-treated fruits either at 5 or 10 mM did not significantly vary from carotenes in the control fruits throughout the sampling periods from the second to the fifth week of spray. When a similar comparison was made with GA_3 at 200 or 400 ppm, it was found that GA_3-treated fruit at 200 ppm had a similar amount of carotenes as compared with the control throughout the sampling period (from week 2 to week 5 of spray) except with fifth week where carotenes decreased significantly by GA_3 at 200 ppm. However, GA_3 at 400 ppm resulted in a different trend throughout the

sampling period since it was able to cause a significantly decline in carotene by the second week of spray as compared with the control, then carotenes did not vary by third and fourth weeks, then increased again by the fifth week to a level similar to the control. On the other hand, calcium-treated fruits did not vary in their carotene content throughout the sampling weeks following spray when compared with that of the control fruits. The incorporation of $CaCl_2$ into GA_3 or putrescine solutions did not make a significant change in the trend of results as compared with its absence from these solutions in both seasons.

4- Anthocyanin Content:

The response of "Desert Red" peaches to the interaction between treatments and time in terms of anthocyanin content in the skin was reported in Table 6. The data shown that anthocyanin formation in the fruit skin of the control needed more than three weeks after spray to reach to a significant amount. Putrescine at 5 mM showed its effect on retarding fruit coloration after 4 weeks of spray, when compared with the control. However, putrescine at 10 mM was more effective in that aspect since the significant reduction in anthocyanin content appeared only after 3 weeks of spray. The consistent retardation of anthocyanin formation by GA_3 whether at 200 or 400 ppm also was manifested after 4 weeks of spray. Meanwhile, there was no significant difference between the influence of GA_3 and putrescine at both used concentrations. The incorporation of calcium with GA_3 or putrescine did not lead to an appreciated change in anthocyanin content in the fruit skin over time. Calcium alone, on the other hand, was able to delay anthocyanin formation but after 4 weeks of spray. After 5 weeks of the application, it was evident that the control fruits of "Desert Red" were superior in their content of anthocyanin when compared with all other treatments. Furthermore, putrescine and GA_3 were equally effective on reducing anthocyanin content after 5 weeks of spray.

5- Total Sugars Percentage:

Changes in total sugars of "Desert Red" peaches in response to the interaction between treatments and time were reported in Table 7. The data showed a gradual increase in total sugars of the control and treatments over time from the first to fifth week after spray. The increase in total sugars from one week to another following spray was

significant until harvest. However, the consistent increase in total sugars with putrescine 10 mM occurred by the third week after spray. Meanwhile, after three week of spray, formation of total sugars by putrescine at 5 and 10 mM was similar to that found by GA_3 at 200 and 400 ppm. The incorporation of calcium chloride to GA_3 at both concentrations did not lead to an appreciated change in total sugars as compared with that found with GA_3 alone after four weeks of spray. Values of total sugars obtained with $CaCl_2$ alone over the five weeks of sampling after spray did not significantly vary from those obtained with the control fruit. Putrescine at 5 and 10 mM plus calcium did not lead to a considerable difference over the five weeks period of sampling after spray. In general, there was no superior treatment in terms of its ability to retard total sugar accumulation in "Desert Red" peaches, over the sampling period.

6- Reducing sugars Percentage:

Data regarding the effect of the interaction between treatments and time on reducing sugars of "Desert Red" peaches was shown in Table 8. The data revealed that reducing sugars of the control fruits tended to increase after 2 and 3 weeks of spray relative to the first week but were drastically reduced after 4 and 5 weeks in both seasons. Similar trend was found with the putrescine at 5 mM where the significant reduction in reducing sugars occurred after 4 and 5 weeks of spray. Moreover, reducing sugars after 5 weeks were further reduced as compared with the forth week. GA_3 application at 200 and 400 ppm gave similar trend of results as those found with putrescine over time. However, reducing sugars content in the control fruits after one week of spray did not significantly vary from those of all other treatments at the same sampling time. The incorporation of calcium chloride with putrescine at 5 or 10 mM resulted in a significant increase in reducing sugars after 2 weeks of spray relative to the first week, then such sugars were significantly declined by reaching to the forth and fifth weeks following spray. The influence of GA_3 plus calcium on reducing sugars from one week to another after spray was similar to that above found by putrescine plus calcium. Thus, various treatments led to similar pattern of reducing sugars over the five weeks that following the application date.

7- Non-reducing Percentage:

Non-reducing sugars were also studied in relation to the interaction between treatments and time as reported in Table 9. Up to the second week following spray, there was no significant change in the control in non-reducing sugars. Then by the third week, non-reducing sugars were increased markedly. The magnitude of such weekly increase from the third to the fifth week following spray was statistically significant. In general, one week after spray, there was no significant difference in non-reducing sugars between treatments and the control. As the time progressed, differences in non-reducing sugars between the control and some treatments were not considerable when compared at various time after spray. Even with calcium chloride alone, the increment in non-reducing sugars, starting after 2 weeks of spray, was significant from one week to another until fifth week. Thus, non of treatments was able to induce a significant change in such sugars as compared with the control or other treatments over the five weeks period after spray. It is important to emphasize that GA_3 at 200 or 400 ppm and putrescine at 5 or 10 mM did not cause variations in non-reducing sugars even in the last three weeks before harvest. The data also clarified the important of the last week in increasing markedly the amount of non-reducing sugars before harvesting whether in the control or treatments.

8- Total Soluble Solids:

The effect of the interaction between treatments and time on the content of total soluble solids (TSS) in "Desert Red" peaches was shown in Table 10. A significant increase in TSS occurred in the control fruits by the second week as compared with the first week following spray. Such increase continued from week to another in a significant manner. Putrescine at 5 or 10 mM also caused a significant increase in TSS in the second week following spray. This was not the case with GA_3 since the increase in TSS was not consistent by the second week relative to the first one. Calcium chloride treatment also did not cause a delay in the accumulation of TSS since the amount of TSS by the second week was higher than that found by the first week following spray. The presence of calcium along with putrescine at 5 or 10 mM resulted in inconsistent increase in TSS up to the third week following spray. Even in the case of GA_3 plus calcium chloride, the consistent in TSS started by the forth week after spray as compared

with the first week. In general, non of treatments was able to accelerate the process of accumulating TSS in "Desert Red" peaches. At the fifth week following spray, no considerable difference was reported between various treatments and the control.

9- Juice Acidity:

Titratable acidity data in "Desert Red" peaches as influenced by the interaction between treatments and time was reported in Table 11. It was found that such acidity in the control fruits increased significantly during the second and third weeks of spray relative to the first week then slightly declined or stayed constant. This rise in acidity occurring consistently by the forth week of spraying putrescine at 5 mM. Meanwhile, use of putrescine at 10 mM lead to considerable increase in acidity that started early in the second week of spray and remained statistically greater than that of the control over the following weeks until harvest. GA_3 (at 200 ppm) influence on titratable acidity varied from than that found by putrescine over time. There was a significant rise in that acidity by the third and forth weeks of spray when compared with the fifth week, then acidity declined by the fifth week but in a non significant way when compared with the forth week. These trends of acidity also true for GA_3 at 400 ppm. The influence of calcium chloride on fruit acidity was even different over time since the consistent increase in such acidity started relatively late by the forth and fifth weeks following spray. However, the presence of calcium along with putrescine at 5 and 10 mM or with GA_3 at both used concentrations did not remarkably change the magnitude of fruit acidity over time until reached to the fifth week. Thus, putrescine and GA_3 solutions seemed to accelerate the increase fruit acidity while calcium chloride alone needed more time to significantly raise such acidity.

10- TSS/Acidity Ratio:

Changes in TSS / acidity ratio as influenced by various treatments over time were shown in Table 12. Such ratio in the control fruits was declined in a considerable manner by the third week of spray as compared with the first week then rose again by reaching to the fifth week. Meanwhile, there was no significant difference in the ratio of TSS to acidity between the control and all other treatments after one week of spray in both seasons. Putrescine at 5 and 10 mM resulted in a difference trend of TSS to acidity ratio since the decline

in such ratio was faster than that was found in the control in the first season but was not difference from by reaching to the fifth week. Application of GA_3 at 200 ppm caused to a significant reduction in the third week of spray relative to the first week in the TSS / acidity ration then such ratio rose again and stayed at that level until the fifth week. However, GA_3 at 400 ppm resulted in slightly different behavior of TSS / acidity ratio since the significant decline in such ratio by third week was followed by another week of spray which stayed at same level until harvest. The application of calcium chloride resulted in slight but inconsistent reduction in the TSS to acidity ratio by the forth week of spray and remained at that level until the fifth week of spray. Non of the treatments resulted in a significant change in TSS to acidity ratio by the fifth week of spray as compared with the control. The presence of calcium chloride along with putrescine at 5 or 10 mM did not change trends of TSS to acidity when compared with those found with putrescine alone. Similar conclusion was reached when GA_3 at both concentrations was compared with GA_3 in the presence of calcium chloride in terms of their influence on TSS / acidity ratio.

(Table 3) Chlorophyll a (mg/L) of "Desert Red" peach fruits as influenced by the interaction between treatments and time during the two seasons 2005 and 2006:

Treatment	Second week		Third week		Fourth week		Fifth week	
	2005	2006	2005	2006	2005	2006	2005	2006
Control	0.405 def	0.425 cd	0.163 jkl	0.192 lmno	0 141 lm	0.158 no	0.095 m	0.148 o
Putrescine 5mM	0.467 cd	0 430 c	0.172 hijkl	0.186 lmno	0.207 hijk	0.229 klmn	0.166 hijkl	0.185 lmno
Putrescine 10mM	0.473 c	0.328 efgh	0.208 hijk	0 244 jklm	0.195 hijkl	0.221 klmn o	0.186 hijkl	0.208 klmno
GA_3 200ppm	0.370 f	0 386 cdef	0 186 hijkl	0.222 klmn	0.185 hijkl	0.199 klmn o	0 158 jklm	0.166 no
GA_3 400ppm	0.428 cdef	0 306 ghij	0 150 jklm	0.186 lmno	0.192 hijkl	0.213 klmn o	0 195 hijkl	0.214 klmno
Putrescine 5mM + $CaCl_2$ 2%	0.348 g	0.372 cdefg	0.230 hi	0 266 hijk	0.214 hij	0.231 klmn	0 166 hijkl	0.175 mno
Putrescine 10mM + $CaCl_2$ 2%	0.414 cdefg	0 400 cde	0 189 hijkl	0.225 klmn	0 196 hijkl	0.221 klmn o	0 169 hijkl	0.187 lmno
GA_3 200ppm + $CaCl_2$ 2%	0.442 cde	0 319 fghi	0 215 hij	0.251 ijkl	0.194 hijkl	0.208 klmn o	0.186 hijkl	0.195 klmno
GA_3 400ppm + $CaCl_2$ 2%	0 361 g	0.354 defg	0 186 hijkl	0 222 klmn	0 232 h	0.250 ijkl	0 177 hijkl	0 179 lmno
$CaCl_2$ 2%	0.396 ef	0.363 cdefg	0.154 jklm	0.192 lmno	0.16 4 ijkl	0.18 8 lmno	0.14 5 klm	0.164 no

Values, within the table, of similar letters were not significantly different where compared by using the least significant difference (LSD) at 0.05 level.

Table (4) Chlorophyll b (mg/L) of "Desert Red" peach fruits as influenced by the interaction between treatments and time during the two seasons 2005 and 2006:

Treatment	Second week		Third week		Fourth week		Fifth week	
	2005	2006	2005	2006	2005	2006	2005	2006
Control	0.121 cdefgh	0.247 cd	0.100 efgh	0.133 hijklmn	0.068 h	0.081 n	0.095 fgh	0.091 mn
Putrescine 5mM	0.164 bcd	0.250 cd	0.095 fgh	0.117 klmn	0.145 bcdefg	0.159 fghijkl	0.103 efgh	0.115 klmn
Putrescine 10mM	0 167 bc	0 183 defghi	0.136 bcdefg	0.181 defghij	0.152 bcdef	0.158 fghijkl	0.109 defgh	0.119 jklmn
GA_3 200ppm	0.099 efgh	0.271 c	0.104 efgh	0.150 fghijklm	0.119 cdefgh	0.133 hijklmn	0.094 gh	0.103 lmn
GA_3 400ppm	0 188 b	0 194 defgh	0 106 efgh	0 151 fghijklm	0 106 efgh	0.118 klmn	0.102 efgh	0.117 klmn
Putrescine 5mM + $CaCl_2$ 2%	0 111 cdefgh	0 210 cde	0.106 efgh	0 124 ijklmn	0.124 cdefgh	0.136 hijklmn	0.119 cdefgh	0.136 hijklmn
Putrescine 10mM + $CaCl_2$ 2%	0.127 cdefg	0.228 cde	0.119 cdefgh	0.138 hijklmn	0 132 bcdefg	0 142 ghijklmn	0 102 efgh	0.114 klmn
GA_3 200ppm + $CaCl_2$ 2%	0.145 bcdefg	0.183 defghi	0.143 bcdefg	0 188 defgh	0 102 efgh	0.083 n	0.098 fgh	0.100 lmn
GA_3 400ppm + $CaCl_2$ 2%	0.100 efgh	0.181 defghij	0.110 cdefgh	0 139 hijklmn	0.156 bcde	0 168 defghijk	0.095 fgh	0 102 lmn
$CaCl_2$ 2%	0.098 fgh	0.204 defg	0.114 cdefgh	0.117 klmn	0 113 cdefgh	0 125 ijklmn	0.097 fgh	0 108 klmn

Values, within the table, of similar letters were not significantly different where compared by using the least significant difference (LSD) at 0.05 level.

(Table 5) Carotene (mg/100gm) of "Desert Red" peach fruits as influenced by the interaction between treatments and time during the two seasons 2005 and 2006:

Treatment	Second week		Third week		Fourth week		Fifth week	
	2005	2006	2005	2006	2005	2006	2005	2006
Control	0.992 a	0.992 abcdef	0.738 efghi	0.807 fghijklmn	0.777 bcdefghi	0.853 bcdefghijklmn	0.995 a	1.046 ab
Putrescine 5mM	0.970 ab	0.970 abcdefgh	0.791 bcdefghi	0.797 ghijklmn	0.792 bcdefghi	0.863 bcdefghijklmn	0.952 abc	1.028 abcd
Putrescine 10mM	0.835 abcdefghi	0.835 defghijklmn	0.88092 abcdefg	0.8870 abcdefghijklmn	0.752 defghi	0.825 efghijklmn	0.970 ab	1.042 ab
GA3 200ppm	0.9137 abcdef	0.913 abcdefghijklm	0.865 abcdefgh	0.872 bcdefghijklmn	0.647 i	0.726 mn	0.652 i	0.735 lmn
GA3 400ppm	0.762 cdefghi	0.762 ijklmn	0.707 ghi	0.713 n	0.677 hi	0.751 klmn	0.934 abcde	1.009 abcde
Putrescine 5mM + $CaCl_2$ 2%	0.945 abcd	0.945 abcdefghij	0.906 abcdef	0.9126 abcdefghijklm	0.765 cdefghi	0.841 cdefghijklmn	0.872 abcdefgh	0.955 abcdefghi
Putrescine 10mM + $CaCl_2$ 2%	1.000 a	1.000 abcdef	0.772 cdefghi	0.778 hijklmn	0.790 bcdefghi	0.857 bcdefghijklmn	0.956 abc	1.032 abc
GA3 200ppm + $CaCl_2$ 2%	0.755 defghi	0.755 jklmn	0.932 abcde	0.938 abcdefghijk	0.782 bcdefghi	0.864 bcdefghijklmn	0.899 abcdefg	0.982 abcdefg
GA3 400ppm + $CaCl_2$ 2%	0.884 abcdefg	0.884 abcdefghijklmn	0.915 abcdef	0.921 abcdefghijkl	0.868 abcdefgh	0.944 abcdefghijk	0.884 abcdefg	0.971 abcdefgh
$CaCl_2$ 2%	0.925 abcde	0.925 abcdefghijkl	0.772 cdefghi	0.833 efghijklmn	0.724 fghi	0.793 ghijklmn	1.000 a	1.074 a

Values, within the table, of similar letters were not significantly different where compared by using the least significant difference (LSD) at 0.05 level.

(Table 6): Anthocyanin (mg/L) of "Desert Red" peach fruits as influenced by the interaction between treatments and time during the two seasons 2005 and 2006:

Treatment	Second week		Third week		Fourth week		Fifth week	
	2005	2006	2005	2006	2005	2006	2005	2006
Control	3.667 hijkl	4.349 defgh	4.030 efghi	3.643 hijklmnopqr	6.322 h	5.677 e	8.250 a	9.794 a
Putrescine 5mM	3.040 mnop	3.307 mnopqrst	3.575 ghijklmno	3.009 qrst	3.595 ghijklmn	3.161 pqrst	3.622 ghijklm	3.936 efghijklmn
Putrescine 10mM	3.002 op	3.822 fghijklmnop	3.445 jklmno	2.922 rst	3.482 ghijklmno	3.367 klmnopqrst	4.047 efgh	3.909 efghijklmno
GA3 200ppm	2.772 p	4.284 defghi	3.465 ijklmno	2.830 st	3.555 ghijklmno	3.312 mnopqrst	4.700 cd	4.555 de
GA3 400ppm	3.380 jklmno	3.562 mnopqr	3.035 nop	3.226 nopqrst	3.572 ghijklmno	3.296 mnopqrst	4.427 def	4.240 defghij
Putrescine 5mM + $CaCl_2$ 2%	3.312 jklmnop	3.980 efghijklm	3.475 ghijklmno	3.670 hijklmnopq	3.027 nop	3.297 mnopqrst	4.055 efg	3.893 efghijklmno
Putrescine 10mM + $CaCl_2$ 2%	3.447 jklmno	4.094 efghijk	3.665 ghijkl	3.394 klmnopqrst	3.007 op	3.692 ghijklmnopq	3.860 fghij	4.473 def
GA3 200ppm + $CaCl_2$ 2%	3.480 ghijklmn	3.953 efghijklmn	3.145 lmnop	3.394 klmnopqrst	3.145 lmnop	3.708 ghijklmnopq	4.480 de	4.473 def
GA3 400ppm + $CaCl_2$ 2%	3.155 lmnop	4.403 defg	3.395 jklmno	2.749 t	3.315 jklmnop	3.687 ghijklmnopq	4.847 cd	4.527 def
$CaCl_2$ 2%	3.360 jklmno	4.739 d	3.752 ghijk	3.524 jklmnopqrs	3.452 ijklmno	4.018 defghijklm	5.200 c	7.255 b

Values, within the table, of similar letters were not significantly different where compared by using the least significant difference (LSD) at 0.05 level.

(Table 7): Total sugars (%) of "Desert Red" peach fruits as influenced by the interaction between treatments and time during the two seasons 2005 and 2006:

Treatment	Second week		Third week		Fourth week		Fifth week	
	2005	2006	2005	2006	2005	2006	2005	2006
Control	5.490 cde	5.445 b	5.510 cde	5.572 b	5.600 c	5.587 b	7.265 ab	7.412 a
Putrescine 5mM	5.320 defghi	5.290 bcd	5.480 cde	5.455 b	5.490 cde	5.472 b	7.180 ab	7.320 a
Putrescine 10mM	5.305 efghi	5.300 bcd	5.480 cde	5.460 b	5.475 cde	5.467 b	7.200 ab	7.270 a
GA_3 200ppm	5.355 cdefghi	5.355 bcd	5.450 cdef	5.410 bc	5.500 cde	5.455 b	7.185 ab	7.197 a
GA_3 400ppm	5.355 cdefghi	5.345 bcd	5.475 cde	5.465 b	5.485 cde	5.440 b	7.315 ab	7.210 a
Putrescine 5mM + $CaCl_2$ 2%	5.395 cdefgh	5.370 bc	5.600 c	5.502 b	5.450 cdef	5.480 b	7.100 b	7.205 a
Putrescine 10mM + $CaCl_2$ 2%	5.435 cdefgh	5.390 bc	5.550 cde	5.575 b	5.520 cde	5.510 b	7.315 ab	7.337 a
GA_3 200ppm + $CaCl_2$ 2%	5.355 cdefghi	5.355 bcd	5.545 cde	5.545 b	5.385 cdefgh	5.460 b	7.370 ab	7.117 a
GA_3 400ppm + $CaCl_2$ 2%	5.400 cdefgh	5.345 bcd	5.585 cd	5.480 b	5.480 cde	5.370 bc	7.395 a	7.390 a
$CaCl_2$ 2%	5.405 cdefgh	5.345 bcd	5.555 cde	5.512 b	5.430 cdefg	5.410 bc	7.345 ab	7.355 a

Values, within the table, of similar letters were not significantly different where compared by using the least significant difference (LSD) at 0.05 level.

(Table 8) Reducing sugars (%) of "Desert Red" peach fruits as influenced by the interaction between treatments and time during the two seasons 2005 and 2006:

Treatment	Second week		Third week		Fourth week		Fifth week	
	2005	2006	2005	2006	2005	2006	2005	2006
Control	1.287 abcdef	1.667 abc	1.272 abcdefg	1.473 cd	0.353 lmnopq	0.387 ghij	0.164 s	0.345 ghij
Putrescine 5mM	1.167 defghijk	1.559 bc	1.282 abcdef	1.199 e	0.336 lmnopqr	0.510 fgh	0.136 s	0.379 ghij
Putrescine 10mM	1.167 defghijk	1.698 ab	1.295 abcdef	1.353 de	0.444 lm	0.400 ghij	0.179 rs	0.327 hij
GA_3 200ppm	1.090 hijk	1.764 a	1.175 defghijk	1.155 e	0.381 lmnop	0.476 fghij	0.228 pqrs	0.366 ghij
GA_3 400ppm	1.167 defghijk	1.731 ab	1.310 abcdef	1.247 e	0.412 lmn	0.450 fghij	0.248 opqrs	0.343 ghij
Putrescine 5mM + $CaCl_2$ 2%	1.287 abcdef	1.568 abc	1.385 ab	1.232 e	0.423 lmn	0.534 fg	0.200 qrs	0.283 j
Putrescine 10mM + $CaCl_2$ 2%	1.302 abcdef	1.590 abc	1.320 abc	1.207 e	0.463 l	0.426 fghij	0.272 nopqrs	0.301 ij
GA_3 200ppm + $CaCl_2$ 2%	1.202 defghij	1.731 ab	1.427 a	1.198 e	0.414 lmn	0.604 f	0.346 lmnopq	0.295 ij
GA_3 400ppm + $CaCl_2$ 2%	1.372 abc	1.733 ab	1.427 a	1.219 e	0.426 lmn	0.451 fghij	0.389 lmnop	0.393 ghij
$CaCl_2$ 2%	1.212 cdefghi	1.601 abc	1.307 abcdef	1.200 e	0.407 lmno	0.490 fghi	0.287 nopqrs	0.364 ghij

Values, within the table, of similar letters were not significantly different where compared by using the least significant difference (LSD) at 0.05 level.

(Table 9): Non reducing sugars (%) of "Desert Red" peach fruits as influenced by the interaction between treatments and time during the two seasons 2005 and 2006:

Treatment	Second week		Third week		Fourth week		Fifth week	
	2005	2006	2005	2006	2005	2006	2005	2006
Control	4.20 cd	3.77 gh	4.23 c	4.09 def	5.24 b	5.20 b	7.10 a	7.06 a
Putrescine 5mM	4.15 cd	3.73 gh	4.19 cd	4.25 d	5.15 b	4.96 bc	7.04 a	6.94 a
Putrescine 10mM	4.13 cd	3.60 ghi	4.18 cd	4.10 def	5.03 b	5.06 bc	7.02 a	6.94 a
GA_3 200ppm	4.26 c	3.59 ghi	4.27 c	4.25 d	5.11 b	4.97 bc	6.95 a	6.83 a
GA_3 400ppm	4.18 cd	3.61 ghi	4.16 cd	4.21 d	5.07 b	4.98 bc	7.06 a	6.86 a
Putrescine 5mM + $CaCl_2$ 2%	4.10 cd	3.80 efg	4.21 c	4.27 d	5.02 b	4.94 bc	6.89 a	6.92 a
Putrescine 10mM + $CaCl_2$ 2%	4.13 cd	3.79 fg	4.23 c	4.36 d	5.05 b	5.08 bc	7.04 a	7.03 a
GA_3 200ppm + $CaCl_2$ 2%	4.15 cd	3.62 ghi	4.11 cd	4.34 d	4.97 b	4.85 c	7.02 a	6.82 a
GA_3 400ppm + $CaCl_2$ 2%	4.02 cd	3.61 ghi	4.15 cd	4.26 d	4.15 cd	4.91 bc	7.00 a	6.99 a
$CaCl_2$ 2%	4.19 cd	3.74 gh	4.24 c	4.31 d	5.02 b	4.92 bc	7.05 a	6.99 a

Values, within the table, of similar letters were not significantly different where compared by using the least significant difference (LSD) at 0.05 level.

(Table 10) TSS (%) of "Desert Red" peach fruits as influenced by the interaction between treatments and time during the two seasons 2005 and 2006:

Treatment	Second week		Third week		Fourth week		Fifth week	
	2005	2006	2005	2006	2005	2006	2005	2006
Control	7.050 efgh	8.400 cdef	7.200 defg	8.400 cdef	8.400 a	9.150 a	7.650 bcd	8.850 abc
Putrescine 5mM	6.900 fghi	8.400 cdef	7.200 defg	8.400 cdef	8.050 ab	8.850 abc	7.500 cde	8.850 abc
Putrescine 10mM	7.050 efgh	7.950 fg	7.500 cde	8.250 def	7.800 ab	8.850 abc	7.650 bcd	8.400 cdef
GA_3 200ppm	6.450 ijkl	8.250 def	6.750 ghij	8.550 bcde	7.800 ab	8.850 abc	7.650 bcd	8.400 cdef
GA_3 400ppm	6.450 ijkl	8.100 ef	7.200 defg	8.400 cdef	8.100 ab	8.850 abc	7.500 cde	8.700 abcd
Putrescine 5mM + $CaCl_2$ 2%	7.050 efgh	8.400 cdef	7.050 efgh	8.400 cdef	7.800 ab	8.550 bcde	7.500 cde	8.550 bcde
Putrescine 10mM + $CaCl_2$ 2%	7.050 efgh	8.250 def	7.200 defg	8.100 ef	7.800 ab	8.850 abc	7.500 cde	8.400 cdef
GA_3 200ppm + $CaCl_2$ 2%	6.750 ghij	8.400 cdef	7.200 defg	8.250 def	8.100 ab	8.850 abc	7.200 defg	8.550 bcde
GA_3 400ppm + $CaCl_2$ 2%	7.050 efgh	8.100 ef	7.500 cde	8.100 ef	7.800 ab	8.550 bcde	7.650 bcd	8.400 cdef
$CaCl_2$ 2%	7.350 cdef	8.400 cdef	7.200 defg	8.550 bcde	7.650 bcd	9.000 ab	7.800 bc	8.850 abc

Values, within the table, of similar letters were not significantly different where compared by using the least significant difference (LSD) at 0.05 level.

(Table 11): Acidity (%) of "Desert Red" peach fruits as influenced by the interaction between treatments and time during the two seasons 2005 and 2006:

Treatment	Second week		Third week		Fourth week		Fifth week	
	2005	2006	2005	2006	2005	2006	2005	2006
Control	0.622 ijklmnop	0.582 k	0.702 bcdefghi	0.842 defghij	0.690 cdefghijk	0.807 j	0.615 ijklmnopq	0.804 j
Putrescine 5mM	0.630 hijklmno	0.552 klmno	0.765 abc	0.797 j	0.715 abcdefg	0.876 abcdef	0.690 cdefghijk	0.813 ij
Putrescine 10mM	0.715 abcdefg	0.552 klmno	0.797 a	0.876 abcdef	0.725 abcde	0.864 cdefgh	0.670 defghijklm	0.822 ghij
GA_3 200ppm	0.640 fghijklmn	0.566 klmn	0.737 abcd	0.888 abcd	0.720 abcdef	0.878 abcdef	0.675 defghijklm	0.832 fghij
GA_3 400ppm	0.592 mnopqrs	0.560 klmno	0.780 ab	0.920 a	0.740 abcd	0.864 cdefgh	0.712 bcdefgh	0.836 fghij
Putrescine 5mM + $CaCl_2$ 2%	0.682 cdefghijkl	0.572 kl	0.615 ijklmnopq	0.808 j	0.690 cdefghijk	0.826 ghij	0.695 cdefghij	0.824 ghij
Putrescine 10mM + $CaCl_2$ 2%	0.637 fghijklmno	0.570 klm	0.672 defghijklm	0.859 cdefghi	0.687 cdefghijk	0.870 bcdefg	0.645 efghijklmn	0.811 ij
GA_3 200ppm + $CaCl_2$ 2%	0.527 rstu	0.566 klmn	0.665 defghijklm	0.817 hij	0.670 defghijklm	0.886 bcde	0.642 efghijklmn	0.838 efghij
GA_3 400ppm + $CaCl_2$ 2%	0.555 opqrst	0.562 klmn	0.737 abcd	0.914 ab	0.740 abcd	0.878 abcdef	0.600 lmnopqr	0.818 hij
$CaCl_2$ 2%	0.607 klmnopqr	0.572 kl	0.610 klmnopqr	0.898 abc	0.715 abcdefg	0.888 abcd	0.632 ghijklmno	0.814 ij

Values, within the table, of similar letters were not significantly different where compared by using the least significant difference (LSD) at 0.05 level.

(Table 12) TSS / acidity (%) of "Desert Red" peach fruits as influenced by the interaction between treatments and time during the two seasons 2005 and 2006:

Treatment	Second week		Third week		Fourth week		Fifth week	
	2005	2006	2005	2006	2005	2006	2005	2006
Control	11.432 ghijklmnop	14.555 abcd	10.455 mnopqrs	9.985 lmnopq	12.185 defghijkl	11.330 ij	12.487 cdefghij	11.002 jk
Putrescine 5mM	10.987 jklmnopqr	15.222 a	9.475 qrs	10.555 jklm	11.332 ghijklmnop	10.097 klmnop	10.872 jklmnopqrs	10.875 jkl
Putrescine 10mM	9.870 pqrs	14.380 abcdefg	9.440 qrs	9.445 pqr	10.790 klmnopqrs	10.257 klmnop	11.485 ghijklmnop	10.210 klmnop
GA_3 200ppm	10.237 opqrs	14.577 abcd	9.372 rs	9.652 mnopqr	10.840 jklmnopqrs	10.107 klmnop	11.365 ghijklmnop	10.082 lmnop
GA_3 400ppm	10.905 jklmnopqr	14.462 abcdef	9.240 s	9.160 qr	10.970 jklmnopqr	10.237 klmnop	10.585 lmnopqrs	10.414 klmn
Putrescine 5mM + $CaCl_2$ 2%	10.330 nopqrs	14.707 abc	11.512 ghijklmnop	10.395 klmno	11.330 ghijklmnop	10.340 klmnop	10.825 jklmnopqrs	10.370 klmno
Putrescine 10mM + $CaCl_2$ 2%	11.080 ijklmnopq	14.485 abcde	10.940 jklmnopqr	9.487 opqr	11.382 ghijklmnop	10.177 klmnop	11.667 efghijklmno	10.352 klmnop
GA_3 200ppm + $CaCl_2$ 2%	13.177 abcdef	14.850 ab	10.947 jklmnopqr	10.107 klmnop	12.085 efghijklm	10.027 lmnopq	11.215 hijklmnop	10.200 klmnop
GA_3 400ppm + $CaCl_2$ 2%	12.722 bcdefghi	14.415 abcdef	10.442 mnopqrs	8.860 r	10.565 lmnopqrs	9.747 nopqr	12.852 bcdefgh	10.267 klmnop
$CaCl_2$ 2%	12.262 cdefghijk	14.697 abcd	11.820 efghijklmno	9.532 nopqr	10.722 klmnopqrs	10.142 klmnop	12.365 cdefghijk	10.867 jkl

Values, within the table, of similar letters were not significantly different where compared by using the least significant difference (LSD) at 0.05 level.

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الملخص العربى

تاثير البيوترسين و حمض الجبريلليك و الكالسيوم على خصائص الجودة و تاخير اكتمال نمو ثمار الخوخ "ديزرت ريد". B : الخصائص الكيماوية للثمار.

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اجريت هذه الدراسة خلال موسمين متتالين 2005، 2006 على اشجار صنف الخوخ "ديزرت ريد" و المطعومة على اصل النيماجارد، و قد تم رش الاشجار برشاشة يدوية حتى نقطة الجريان السطحى و تم الرش فى بداية المرحلة الثالثة من منحنى نمو الثمار الزيجمودى، اى قبل بداية تنفس النضج للثمار بهدف دراسة امكانية تاخير اكتمال نمو ثمار ذلك الصنف و معرفة مدى تاثر الخصائص الكيماوية للثمرة. و قد اشتملت

المعاملات على استحدام كل من البيوترسين بتركيزى 5 او 10 ملى مولار، حمض الجبريلليك بتركيزى 200، 400 جزء فى المليون ، كلوريد الكالسيوم بتركيز 2% (وزن/حجم)،و الكنترول (رش بالماء)، باضافة لكل من تركيزين البيوترسين او حمض الجبريلليك فى وجود كلوريد الكالسيوم. أضيفت المادة الناشره توين 80 لكل محاليل المعاملات بتركيز 0.05% (حجم/حجم). و قد وجد ان الثمار المعاملة بالبيوترسين احتوت على قدر اكبر من الكلورفيل أ و ذلك بالمقارنة بالكنترول، و بطريقة مشابهة ادت المعاملة بحمض الجبريلليك الى الحصول على محتوى اعلى من الكلورفيل أ خاصة فى الموسم الاول بينما لم يؤثر كلوريد الكالسيوم معنويا على كلورفيل أ فى كلا الموسمين، كما وجد ان تركيزى البيوترسين، و كذلك كلوريد الكالسيوم بمفردة لم تؤثر معنويا على محتوى الثمار من الكاروتينات، بينما نتج عن معاملة حمض الجبريلليك عند تركيز 200 جزء فى المليون نقص معنوى فى الكاروتينات و ذلك بالمقارنة بالكنترول. لكن مضاعفة التركيز الى 400 جزء فى المليون لم بنتج عنها زيادة معنوية فى الكاروتينات بالمقارنة مع معاملة 200 جزء فى المليون، و قد ادت كل تركيزات البيوترسين و حمض الجبريلليك و كلوريد الكالسيوم الى حدوث نقص معنوى فى الانثوسيانين فى كلا الموسمين، بينما وجود الكالسيوم فى تركيبة اى من تركيزات البيوترسين او حمض الجبريلليك لم يؤد الى تغير معنوى فى محتوى الانثوسيانين بالمقارنة مع عدم وجودة. و قد وجد ان هناك نقصا فى نسبة المواد الصلبة الذائبة الى الحموضة و بطريقة ثابتة باستخدام البوترسين بتركيز 10 ملى مولار، كما كان ذلك هو الاتجاه العام لنتائج معاملات حمض الجبريلليك، بينما لم يؤثر كلوريد الكالسيوم معنويا على تلك النسبة فى كلا الموسمين، و قد اثبتت النتائج ان اضافة كلوريد الكالسيوم لاى من تركيزى البيوترسين او حمض الجبريلليك لم يكن ذو ميزة اضافية من ناحية اعطاء اثر اضافى على خفض محتوى الثمار من الصبغات او السكريات. و توصى الدراسة باستخدام GA3 بتركيز 200 جزء فى المليون، او البيوترسين بتركيز 10 ملى مولار (اى 882 جزء فى المليون) لتاخير اكتمال نمو ثمار صنف الخوخ "ديزرت رايد" لمدة حوالى اسبوع على الاقل مع العلم ان الرش يجب ان يتم عند بداية المرحلة الثالثة من منحنى نمو الثمار الزيجمودى المزدوج.