Effect of Some Agro-Chemicals Preharvest Foliar Application on Yield and Fruit Quality of "Swelling" Peach Trees

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Received on: 1/10/2013 *Accepted:19/11/2013*

ABSTRACT

This study was carried out during two successive seasons of 2012 and 2013 in order to study the effect of ascorbic acid (AsA), citric acid (CiA), salicylic acid (SA) each at (0, 200, 400 and 600 ppm), gibberellic acid (GA_3) at (0, 100, 200 and 300 ppm) and calcium chloride ($CaCl_2$) at (0, 0.5, 1.0 and 2% (w/v)) on yield and fruit quality of six years old "Swelling" peach trees(*Prunus persica* L.) grown in sandy soil. Results showed that gibberellic acid significantly increased total yield as compared with other different agro-chemicals in the first season. Meanwhile, in the second season, both ascorbic acid and calcium chloride application led to a marked increase in total yield relative to that found with citric, salicylic and gibberellic acid. Furthermore, GA_3 caused a significant increase in fruit weight and fruit firmness as compared with the other agrochemicals in both seasons. In addition, calcium chloride and salicylic acid had significantly higher firmness than ascorbic and citric acids in both seasons. Both ascorbic and citric acids caused the highest increase in TSS, TSS/ acid ratio, total sugars, non-reducing sugars and anthocyanin content as compared with all other different agro-chemicals. Meanwhile, gibberellic acid, salicylic acid and calcium chloride significantly increased fruit acidity, reducing sugars, chlorophyll a and b contents as compared with that of ascorbic and citric acids. Generally, it could be concluded that, gibberellic acid, salicylic acid and calcium chloride markedly increased yield, fruit firmness and fruit chlorophyll a and b content as compared with all other agrochemicals.

Key words: Swelling- Ascorbic acid- citric acid – salicylic acid – GA_3 -Fruit quality.

INTRODUCTION

The peach *(Prunus persica L.)* is one of the most important stone fruits, due to its heavy loading, dietetic value and as a rich source of carbohydrate, protein and vitamins especially (A, B and C) and some mineral nutrients. According to FAO (2011), Egypt ranks third in the Arab production of peaches. The area cultivated with peach in Egypt is 92000 feddans, and total product of peach fruits is 287183 tons.

Swelling peach is one of the late season cultivars that suffer from accelerated- softened fruits, and therefore, the fruits exhibit short handling period which limits its commercial potential. This concept obligates fruit producer to harvest fruits at early ripening stage. Accordingly, there is a great need to decrease fruit deterioration after harvest and to enhance fruit quality in order to prolong the handling season with acceptable yield. To reach this goal some agro-chemicals can be used such as ascorbic acid, citric acid, salicylic acid, gibberellic acid and calcium chloride.

Ascorbic acid, citric acid and salicylic acid are considered as auxinic action, since they have synergistic effect on growth and productivity of most fruit trees (Ragab, 2002). In addition, the positive action of antioxidants in catching or chelating the free radicals which could result in extending the shelf life of plant cells and stimulating growth aspects is reported (Rao *et al.* 2000). In the mean time, ascorbic acid is considered a regulator of plant growth. Also, citric acid plays an essential role in signal transduction system, membrane stability and functions, activating transporter enzymes, metabolism and translocation of carbohydrates (Smirnoff, 1996). Salicylic acid is an endogenous growth regulator of phenolic nature, which participates in the regulation of several physiological processes in plants such as growth, development, transpiration as well as uptake and transport of nutrients, photosynthesis, nitrate metabolism, ethylene production, (Hayat and Ahmed, 2007). Gibberellins are a group of growth substances, which are known to delay ripening and senescence of fruits (Khader, 1992). The site of ethylene inhibition by gibberellic acid appeared to be related to the ethylene forming enzymes (Ben-Arie and Ferguson, 1991). Calcium is a nutrient that plays an important role in improving fruit quality (Rizk-Alla *et al*. 2006). In addition, calcium has long been known to confer rigidity of cell walls, which in turn reflected on increasing the tissue firmness.

The present investigation aimed at studying the effect of some antioxidants (ascorbic, citric and salicylic acids) as well as, gibberellic acid and calcium chloride sprays on yield and fruit quality of "Swelling" peach trees grown in sandy soil.

MATERIALS AND METHODS

This study was carried out during two successive seasons 2012 and 2013 on six years old Swelling peach trees (*Prunus persica* L.), budded on Nemaguard peach rootstock. Trees were planted in sandy soil in a private orchard at El Nubaria region, El Beheira governorate, Egypt. The trees were spaced at 5 x 5 m, open-vase shape trained, irrigated by drip irrigation system and received similar cultural practices adopted in the orchard.

Eighty trees were selected uniform as possible in growth, productivity and appearance for this study. Trees were sprayed to the run off at pit hardening end of April during 2012 and 2013 seasons. Treatments included water as the control, ascorbic acid (AsA) at (0, 200, 400 and 600 mg/l), citric acid (CiA) at (0, 200, 400 and 600 mg/l), salicylic acid (SA) at (0, 200, 400 and 600 mg/l), gibberellic acid (GA_3) at (0, 100, 200 and 300 mg/l) and calcium chloride ($CaCl_2$) at (0, 0.5, 1.0 and 2% (w/v)) . Trition B emulsifier at a rate of 0.2 % was used with each spray solution as wetting agent.

This experiment consisted of 20 treatments arranged in factorial analysis in a randomized complete block design with four replicates for each treatment and one tree for each replicate. Least significant difference (L.S.D) at 0.05 level of probability (Steel and Torrie, 1984) was used to compare the main effect of the different treatments on the yield and fruit quality.

At harvest (mid-June) the yield as kg /tree was recorded. A sample of 10 fruits per tree from each replicate was randomly collected in both seasons, then transported directly to the laboratory to determine the physical and chemical fruit characteristics. Average fruit weight (g) was determined. Flesh firmness expressed as (pound/ $Inch^2$) was measured in two opposite tropic sides of the fruit using pressure tester according to (Magness and Taylor, 1982). TSS (%) was recorded by hand refractometer according to Chen and Mellenthin (1981). Juice acidity (%) was determined according to (A.O.A.C., 1985) and TSS/acidity ratio was calculated. Sugars content (%) was determined in fresh fruit samples according to Malik and Singh (1980). Chlorophyll a and b (mg/100gm) were determined according to (Wintermans and Mats, 1965). Anthocyanin (mg/100gm) content in fruit peel was determined according to the method of Fuleki and Francis (1968).

RESULTS AND DISCUSSION

The yield

With regard to the effect of sprayed compound, the data presented in Table (1) indicated that, in both seasons, gibberellic acid significantly increased yield as compared with all other sprayed agro-chemicals. Moreover, the application of ascorbic and calcium chloride resulted in greater total yield than that found with salicylic acid in both seasons. In addition, salicylic treatment gave the lowest yield as compared with the chemicals in both seasons. Generally, no significant differences between calcium chloride and ascorbic acid concerning total yield in both seasons.

These results were in line with those obtained by Shahin *et al*. (2010) on "Anna" apple trees and Stino *et al*. (2011) on "Le-Conte" pear trees. They found that yield was generally improved by GA foliar spray.

Regarding the effect of different concentrations, data in Table (1) indicated that, the greatest yield was obtained with the highest concentration in both seasons.

As for the interaction effect between the different agro-chemicals and its concentrations, the data in Table (1) revealed that the highest value of total yield per tree was achieved with calcium chloride at 2.0 % in the first season. Meanwhile, the lowest value of total yield per tree was obtained with trees received salicylic acid at zero ppm in the second season.

The increase in yield obtained by GA_3 treatments might be due to that GA_3 stimulates cell division and cell enlargement which reflects on increasing fruit weight and consequently fruit yield (Moore, 1979). Gibberellic acid creates a sink strength in the fruit cells, thus attracts water and nutrients. The positive effect of ascorbic acid on the yield might be attributed to their vital role acting as natural auxins and their important effects on the biosynthesis of carbohydrates and other organic compounds (Elade, 1992).

Fruit weight:

Regarding the effect of the sprayed agro-chemicals, the data of the first season given in Table (1) indicated that, application of calcium chloride, citric and salicylic acids did not significantly differ from each other in affecting fruit weight, while gibberellic acid caused the highest increase in fruit weight as compared with all other chemicals in both seasons. The addition of ascorbic acid lead to a significant increase in fruit weight when compared with application of salicylic acid and calcium in both seasons.

The mentioned results agreed with the findings of Ismail (2006) on "Desert Red" peach cultivar and Barandoozi and Talaie (2009) on "Golden Delicious" apple fruits. They found that the GA_3 treatments increased the average fruit weight.

Regarding the effect of different applied concentrations, the data in Table (1) showed that, all concentrations increased average fruit weight as compared with the control in both seasons. In the first season the highest concentration resulted in significantly the greatest average fruit weigh. In the second season, no significant difference was obtained between the high and medium concentrations, therefore, it can be concluded that medium concentration could be sufficient to cause a suitable increase in average fruit weight of "Swelling" peach trees.

As for the interaction between the different agro-chemicals and its concentrations, the data presented in Table (1) indicated that the greatest value of average fruit weight was achieved with gibberellic acid at 300 ppm in both seasons. Meanwhile, the lowest value of average fruit weigh was obtained with trees received ascorbic acid at zero mg/l in the first season and SA at zero mg/l in the second one.

The increase in fruit weight by GA_3 treatments could be attributed to the cell enlargement caused by GA_3 application (Moore, 1979). Also, Richard (2006) reported that gibberellic acid promoted growth by increasing plasticity of the cell wall followed by the hydrolysis of starch into sugars which reduces the cell water potential, resulting in the entry of water into the cell and causing elongation.

Fruit firmness:

Results obtained in Table (1) indicated that gibberellic acid significantly increased fruit firmness as compared with all other compounds in both seasons. In addition, calcium chloride and salicylic acid had significantly higher firmness than ascorbic and citric acids. Also, ascorbic acid was effective in a significant manner on increasing peach fruit firmness when compared with citric acid in the first season.

Table 1: Effect of some agro-chemicals preharvest foliar application on the yield, fruit weight and fruit firmness of "Swelling" peach trees during 2012 and 2013 seasons.

Treatments		Yield (Kg/tree)		Average fruit weight (gm)		Firmness (pound /inch^2)	
Agrochemicals	Conc	2012	2013	2012	2013	2012	2013
Ascorbic acid (AsA)	0 ppm	37.56	30.91	99.97	113.88	8.44	7.99
	200 ppm	38.57	31.80	103.33	116.30	8.65	8.46
	400 ppm	38.92	33.03	105.26	118.20	9.98	8.74
	600 ppm	40.57	34.33	106.27	119.32	9.24	9.12
Citric acid (CiA)	0 ppm	36.97	30.89	100.43	114.63	8.46	8.02
	200 ppm	37.60	31.65	100.98	117.06	8.52	8.23
	400 ppm	39.26	32.76	122.74	118.33	8.66	8.47
	600 ppm	39.91	33.25	104.88	118.65	8.99	8.87
Salicylic acid (SA)	0 ppm	36.37	30.60	100.24	112.39	8.64	7.79
	200 ppm	37.15	31.09	99.98	113.28	8.82	8.53
	400 ppm	39.20	32.53	102.23	117.32	9.94	9.63
	600 ppm	40.58	32.85	103.34	117.60	11.18	11.03
Gibberellic acid (GA_3)	0 ppm	37.43	31.20	101.40	113.73	8.52	7.83
	100 ppm	40.68	33.96	104.20	122.61	9.80	9.64
	200 ppm	44.19	34.38	113.64	128.52	10.89	10.75
	300 ppm	43.78	33.72	119.23	130.10	11.45	11.23
Calcium chloride ($CaCl_2$)	0 %	37.13	30.97	101.14	112.77	8.24	7.88
	0.5%	36.87	31.55	100.43	114.47	8.96	8.66
	1.0 %	37.87	32.46	102.12	115.45	10.21	9.87
	2.0 %	45.39	33.55	105.42	116.32	11.36	11.14
L. S. D 0.05		1.66	1.44	2.97	2.59	0.61	0.63
Mean effect of agro-chemicals	AsA	38.91	32.52	103.66	116.92	9.07	8.57
	CiA	38.45	32.14	102.20	117.16	8.66	8.39
	SA	38.32	31.77	101.41	115.14	9.63	9.24
	GA_3	41.52	33.32	109.58	123.73	10.16	9.86
	$CaCl_2$	39.35	32.13	101.99	114.75	9.70	9.38
L. S. D 0.05		0.83	0.75	1.48	1.29	0.31	0.31
Mean effect of concentrations	0	37.09	30.91	100.41	113.48	8.44	7.90
	Low	38.19	32.01	101.76	116.74	8.95	8.70
	Medium	39.91	33.03	105.14	119.56	9.94	9.49
	High	42.05	33.54	107.78	120.39	10.44	10.27
L. S. D 0.05		0.74	0.68	1.32	1.15	0.27	0.28

In this respect, Hassan *et al*. (2010) on "Hollywood" plum trees and Stino *et al*. (2011) on "Le-Conte" pear trees reported that gibberellic acid (GA_3) applications increased firmness. Moreover, Abd- Elnaby and Nadir (2003) on "Swelling" and "Met Ghamer" peach cultivars and Samara *et al.* (2008) on "Desert Red" peach fruits found that fruits treated with calcium chloride retained maximum firmness. Also, Kazemi *et al*. (2011) on "Jonagold" apple fruits found that application of salicylic acid increased fruit firmness.

Concerning the effect of the different concentrations, it is shown that all concentrations significantly increased fruit firmness as compared with the control in both seasons (Table 1). Generally, the high concentration caused a significant increase in fruit firmness as compared with other concentrations in both seasons.

As for the interaction between different chemicals and its concentrations, the data presented in Table (1) indicated that the highest value of fruit firmness was obtained with gibberellic acid at 300 ppm in both seasons. Meanwhile, the lowest value of fruit firmness was obtained with trees did not receive calcium chloride in the first season and salicylic acid in the second one.

Increasing fruit firmness as a result of GA_3 may be attributed to the role of GA_3 in decreasing the polygalacuronases and pectin methylestrase activities, thus GA_3 treatments may maintain fruit firmness by their inhibitory effects on these enzymes (Andrews and Li, 1995).

Furthermore, the increase in fruit firmness as result of calcium treatment may be due to that calcium ions interact with pectic polymers to form a cross-linked polymer network that increases mechanical strength, thus delaying senescence (Glenn and Poovahiah, 1986) .Also, Tobias (1993) found that cell wall-bound Ca^{2+} is involved in maintaining cell wall integrity by binding carboxyl groups of polygalacturonate chains, which are mainly present in the middle lamella and primary cell wall. In addition, Siddiqui and Bangerth (1995) reported that optimizing calcium content of fruit during growth and development is an important issue in order to slow their ripening and softening of fruit flesh by lowering respiration rates and reducing ethylene production. Finally, Exogenous applied calcium therefore stabilizes the plant cell wall and protects it from degrading enzymes which have major influences on firmness (White and Broadly, 2003).

Besides, the increase in fruit firmness as a result of salicylic acid treatments may be due to its influence as a plant hormone in inhibiting ethylene biosynthesis and delaying fuit senescence (Ozeker, 2005). Also, it is reported that SA decreases the activities of major cell wall degrading enzymes; viz. cellulase, polygalacturonase and xylanase (Srivastava and Dwivedi, 2000).

Total soluble solids:

With regard to the different sprayed compounds, results obtained in Table (2) revealed that, spraying ascorbic acid and citric acid resulted in higher TSS than salicylic acid, gibberellic acid and calcium chloride in both seasons with no significant difference between them was occurred. Moreover, the use of calcium chloride caused a marked increase in TSS as compared with gibberellic and salicylic acids in both seasons.

These finding were confirmed with those obtained by Hafez *et al.* (2010) on "Le- Conte" pear fruits. They reported that spraying ascorbic and citric acids improved fruit TSS content. Furthermore, Hussein *et al*. (2001) on "Anna and Dorset Golden" apple reported that, application of GA_3 reduced the total soluble solids.

Concerning the effect of the chemicals at different concentrations on total soluble solids, the data in Table (2) showed a gradual decrease in total soluble solids with increasing concentrations. Moreover, the control treatment gave the greatest total soluble solids as compared with other concentrations in both seasons.

As for the interaction between different compounds and its concentrations, the data of both seasons presented in Table (2) indicated that the highest value of total soluble solids was achieved with ascorbic acid at 600 ppm in the second season, whereas, the lowest value of total soluble solids was obtained with trees received gibberellic acid at 300 ppm.

The increase in total soluble solids as a result of ascorbic and citric acids sprays may be due to their influence in increasing photosynthetic pigment which reflected on photosynthesis process and led to increase in carbohydrate content (Fayed, 2010). Meanwhile, the reduction in the TSS by calcium treated fruits was probably due to that calcium may had slowed down respiration and metabolic activity, hence retarded the ripening process (Rohani *et al.* 1997). Furthermore the decrease in total soluble solids as result of GA_3 treatments may be due to delay in fruit ripening caused by GA_3.

Acidity:

Regarding the sprayed compounds, the data of both seasons presented in Table (2), indicated a general trend of increase of juice acidity as a result of GA_3 treatment when compared with all other chemicals. However, application of salicylic acid and calcium chloride gave higher fruit acidity than spraying ascorbic and citric acids in both seasons. In addition, spraying calcium chloride did not differ from salicylic and gibberellic acids in the second season. Also, data in the second season revealed that, ascorbic and citric acids did not significantly differ from each other.

Table 2: Effect of some agro-chemicals preharvest foliar application on TSS, acidity and TSS: acid ratio of "Swelling" peach fruits during 2012 and 2013 seasons.

Treatments		TSS (%)		Acidity (%)		TSS: acid ratio (%)	
Agro-chemicals	Conc	2012	2013	2012	2013	2012	2013
Ascorbic acid (AsA)	0 ppm	11.22	11.38	0.29	0.28	38.55	39.93
	200 ppm	11.20	11.59	0.31	0.30	36.60	39.02
	400 ppm	12.28	12.32	0.27	0.27	45.15	45.63
	600 ppm	12.40	12.46	0.26	0.25	47.33	49.05
Citric acid (CiA)	0 ppm	11.28	11.37	0.30	0.29	37.35	38.54
	200 ppm	11.44	11.53	0.31	0.30	37.38	38.31
	400 ppm	11.60	11.68	0.29	0.30	40.00	39.06
	600 ppm	11.64	11.74	0.27	0.26	43.43	44.30
Salicylic acid (SA)	0 ppm	11.00	11.22	0.30	0.29	37.04	38.55
	200 ppm	10.84	10.63	0.33	0.34	32.85	31.54
	400 ppm	10.08	9.98	0.34	0.35	30.00	28.51
	600 ppm	9.68	9.74	0.37	0.38	26.02	25.83
Gibberellic acid (GA_3)	0 ppm	11.42	11.58	0.29	0.29	38.97	40.07
	100 ppm	10.40	10.22	0.34	0.32	30.59	29.62
	200 ppm	9.72	9.44	0.38	0.37	25.31	25.72
	300 ppm	9.17	9.17	0.40	0.40	22.75	22.81
Calcium chloride ($CaCl_2$)	0 %	11.32	11.27	0.31	0.30	36.28	37.19
	0.5%	11.21	11.18	0.30	0.32	36.87	34.61
	1.0 %	10.84	10.47	0.33	0.35	33.25	30.17
	2.0 %	10.62	10.12	0.36	0.38	29.34	26.28
L. S. D 0.05		0.67	0.69	0.03	0.03	5.36	5.50
Mean effect of agro-chemicals	AsA	11.77	11.93	0.28	0.28	41.59	43.22
	CiA	11.49	11.58	0.29	0.29	39.49	39.93
	SA	10.40	10.38	0.33	0.34	31.14	30.71
	GA_3	10.17	10.10	0.35	0.35	28.65	28.85
	$CaCl_2$	10.99	10.76	0.33	0.34	33.71	31.74
L. S. D 0.05		0.33	0.34	0.02	0.02	2.66	2.73
Mean effect of concentrations	0	11.25	11.36	0.30	0.29	37.62	38.90
	Low	11.02	11.03	0.32	0.32	34.74	34.46
	Medium	10.90	10.77	0.32	0.33	33.85	33.04
	High	10.70	10.64	0.33	0.34	32.13	31.66
L. S. D 0.05		0.30	0.31	0.01	0.01	2.38	2.44

The above findings agreed with those found by Hussein *et al*. (2001) on "Anna and Dorset Golden" apple and Hassan *et al*. (2010) on "Hollywood" plum fruits. They reported that, application of GA_3 significantly increased titratable acidity. Furthermore, Tareen *et al*. (2012) on "Flordaking" peach fruits found that fruits treated with salicylic acid (SA) significantly increased total acidity contents. Whereas, Fayed (2010) on "Thompson seedless" grapevine reported that spraying ascorbic and citric acid reduced total acidity.

Concerning the effect of different rates on juice acidity, it can be concluded a gradual increase in juice acidity with increasing concentrations Table (2). Generally, the highest concentration gave the greatest juice acidity as compared with other concentrations in both seasons.

As for the interaction between different agro-chemicals and rates on juice acidity the data of both seasons presented in Table (2) indicated that the highest value of juice acidity was achieved with gibberellic acid at 300 mg/l, whereas, the lowest value of juice acidity was obtained with trees received ascorbic acid at 600 mg/l.

The reduction in juice acidity by ascorbic and citric acid treatments could be attributed to its influence on increasing the tissue respiration and increasing ripening-associated activities. Also, the increasing acidity in calcium treated fruits might be due to reduction in metabolic changes of organic acid into carbon dioxide and water (Pila *et al*. 2010).

TSS/ acid ratio:

With regard to the sprayed compounds only, the data in Table (2) revealed that ascorbic acid caused a significant increase in fruit TSS/ acid ratio as compared with salicylic, gibberellic acid and calcium chloride. Meanwhile, it did not differ significantly as compared with that of citric acid in the first season. Moreover, spraying gibberellic acid tended to decrease fruit TSS/ acid ratio in both seasons. Spraying calcium chloride caused an increase in TSS/ acid ratio as compared with that of gibberellic and salicylic acids in the first season only.

These results were in harmony with those obtained by Fayed (2010) on "Thompson seedless" grapevine. They found that, spraying ascorbic and citric acid increased TSS/ acid ratio.

Concerning the effect of different concentrations on fruit TSS/ acid ratio, the data of both seasons presented in Table (2) indicated that, all concentrations resulted in lower TSS/ acid ratio than that of the control with no significant difference among all concentrations was occurred.

As for the interaction between different agro-chemicals and its concentrations, the data in Table (2) showed that the greatest fruit TSS / acid ratio was obtained with ascorbic acid at 600 ppm in both seasons. Meanwhile, the least value of fruit TSS / acid ratio was attained with trees received gibberellic acid at 300 ppm in both seasons.

Total and non-reducing sugars:

With regard to the effect of the sprayed chemicals, the data in Table (3) indicated that, generally, spraying ascorbic acid caused a significant increase in total and non-reducing sugars as compared with salicylic, gibberellic acid and calcium chloride. Meanwhile, it did not differ significantly from applying citric acid in both seasons. Moreover, no significant differences were found among the efficacy of salicylic, gibberellic acids and calcium chloride in terms of the content of total and non-reducing sugars in the first season.

These results were in line with those of Hafez *et al.* (2010) on "Le– Conte" pear fruits. They reported that spraying ascorbic acid and citric acid increased total and non-reducing sugars.

Concerning the effect of different rates on fruit total and non-reducing sugars, the data in Table (3) indicated a gradual decrease in fruit total and non-reducing sugars with increasing concentrations. Moreover, all concentrations resulted in lower fruit total and non-reducing sugars content than the control in both seasons.

As for the interaction effect between the different chemicals and its concentrations, the data in Table (3) showed that the highest fruit total and non-reducing sugars was achieved with ascorbic acid at 600 ppm in the first season and 200 ppm in the second season. Meanwhile, the lowest value of total and non-reducing sugars was attained with trees received calcium chloride at 2.0 % in both seasons.

Reducing sugars:

Data concerning the effect of the various chemicals on reducing sugars content presented in Table (3) showed that, in both seasons, gibberellic acid caused a significant increase in reducing sugars as compared with citric acid, ascorbic acid and calcium chloride. Meanwhile, no significant difference between gibberellic and salicylic acids and among citric acid, ascorbic acid and calcium chloride were noticed in both seasons.

Concerning the effect of the different concentrations, results presented in Table (3) showed that, the high concentration increased reducing sugars as compared with the low and medium concentrations in both seasons.

As for the interaction effect between different chemicals and its concentrations on reducing sugars content, the data in Table (3) showed that the greatest reducing sugars values were obtained with salicylic acid at 600 ppm, gibberellic acid at 300 ppm and calcium chloride at 0.2% in both seasons. Meanwhile, the lowest value of reducing sugars was attained with trees did not receive calcium chloride in both seasons.

Fruit chlorophyll content:

Concerning the effect of the sprayed chemicals only, data shown in Table (4) indicated that chlorophyll a and b in GA_3 treated fruits was significantly higher than that of fruits sprayed with all other compounds in both seasons. In addition, salicylic acid spray resulted in higher chlorophyll a and b content than ascorbic and citric acids and calcium chloride in the first season. Moreover, the application of calcium chloride was significantly increased chlorophyll a and b when compared with ascorbic and citric acids in the first season only.

These results were in line with those obtained by Sher-Mohammed *et al*. (1997) on "Red haven" peach fruit and Ismail (2006) on "Desert Red" peach cultivar. They reported that, GA_3 application resulted an increase in chlorophyll a and b content. Moreover, Pila *et al*. (2010) stated that calcium chloride delayed the change of chlorophyll degradation in tomato fruits.

Regarding the effect of the chemicals concentrations, the data in Table (4) showed that, all concentrations increased chlorophyll a and b content as compared with the control in both seasons. Foliar application of high and medium concentrations caused a significant increase in chlorophyll a and b content as compared with the lower one in both seasons (except in 2013 for chlorophyll b).

As for the interaction effect between the different compounds and its concentrations on chlorophyll a and b content, the data presented in Table (4) showed that the highest value of chlorophyll a and b content were attained with trees treated with GA_3 at 300 ppm in both seasons. Meanwhile, the lowest value of chlorophyll a and b content was detected with trees received citric acid at 600 ppm in both seasons.

Anthocyanin contents:

With regard to the chemicals influence only, the results given in Table (4) indicated that, generally citric and ascorbic acid significantly increased anthocyanin content in both seasons compared to the other sprayed compounds. On the other hand, application of GA_3 led to a significant reduction in anthocyanin content in peach fruits skin as compared with the various chemicals. Retardation of anthocyanin formation was also found by salicylic acid and calcium chloride application in both seasons as compared with that of ascorbic and citric acids.

These results are in harmony with those obtained by Sher-Mohammmad *et al*. (1997) on "Redhaven" peach trees and Ismail (2006) on "Desert Red" peach cultivar. They found that spraying GA_3 delayed anthocyanin accumulation and hence fruit ripening.

Concerning the effect of the different concentrations on anthocyanin contents, the data in Table (4) indicated that, a gradual decrease in anthocyanin content was noticed with increasing the concentration. Fruits of the control trees had the highest anthocyanin content as compared with all other concentrations in both seasons.

Table 3: Effect of some agro-chemicals preharvest foliar application on total, reducing and non-reducing sugars content of "Swelling" peach fruits during 2012 and 2013 seasons.

Treatments		Total sugars (%)		Reducing sugars (%)		Non-reducing sugars (%)	
Agro-chemicals	Conc	2012	2013	2012	2013	2012	2013
Ascorbic acid (AsA)	0 ppm	8.33	8.47	0.66	0.54	7.67	7.93
	200 ppm	8.29	8.59	0.66	0.62	7.63	7.97
	400 ppm	8.43	8.59	0.65	0.72	7.78	7.86
	600 ppm	8.54	8.58	0.64	0.75	7.89	7.83
Citric acid (CiA)	0 ppm	8.28	8.346	0.66	0.61	7.62	7.74
	200 ppm	8.29	8.57	0.65	0.63	7.64	7.95
	400 ppm	8.36	8.43	0.65	0.70	7.71	7.73
	600 ppm	8.47	8.52	0.65	0.75	7.82	7.77
Salicylic acid (SA)	0 ppm	8.32	8.34	0.63	0.75	7.69	7.59
	200 ppm	7.81	7.83	0.66	0.74	7.14	7.09
	400 ppm	7.43	7.50	0.71	0.79	6.72	6.70
	600 ppm	7.38	7.42	0.85	0.83	6.56	6.59
Gibberellic acid (GA_3)	0 ppm	8.20	8.27	0.64	0.76	7.55	7.51
	100 ppm	7.90	8.02	0.67	0.76	7.23	7.26
	200 ppm	7.41	7.54	0.71	0.79	6.70	6.74
	300 ppm	7.40	7.42	0.86	0.81	6.54	6.61
Calcium chloride ($CaCl_2$)	0 %	8.40	8.44	0.61	0.54	7.79	7.89
	0.5%	7.74	7.82	0.63	0.60	7.11	7.22
	1.0 %	7.46	7.49	0.69	0.69	6.77	6.80
	2.0 %	7.33	7.41	0.78	0.85	6.53	6.56
L. S. D 0.05		0.30	0.28	0.06	0.05	0.34	0.33
Mean effect of agro-chemicals	AsA	8.40	8.56	0.65	0.66	7.75	7.90
	CiA	8.35	8.47	0.65	0.67	7.69	7.79
	SA	7.73	7.77	0.72	0.78	7.03	6.99
	GA_3	7.73	7.81	0.72	0.78	7.00	7.03
	$CaCl_2$	7.73	7.94	0.68	0.67	7.05	7.27
L. S. D 0.05		0.15	0.15	0.03	0.02	0.17	0.16
Mean effect of concentrations	0	8.31	8.43	0.64	0.64	7.66	7.79
	Low	8.01	8.19	0.65	0.67	7.35	7.52
	Medium	7.82	7.93	0.68	0.74	7.14	7.19
	High	7.88	7.89	0.76	0.80	7.13	7.09
L. S. D 0.05		0.13	0.14	0.03	0.02	0.15	0.15

Table 4: Effect of some agro-chemicals preharvest foliar application on chlorophyll a, b and anthocyanin contents of "Swelling" peach fruits during 2012 and 2013 seasons.

Treatments		Chlorophyll a (mg/100gm)		Chlorophyll b (mg/100gm)		Anthocyanin (mg/100gm)	
Agro-chemicals	Conc	2012	2013	2012	2013	2012	2013
Ascorbic acid (AsA)	0 ppm	0.328	0.345	0.172	0.202	6.270	6.543
	200 ppm	0.321	0.351	0.176	0.204	6.015	6.321
	400 ppm	0.319	0.347	0.181	0.202	6.218	6.547
	600 ppm	0.319	0.331	0.186	0.199	6.435	6.786
Citric acid (CiA)	0 ppm	0.330	0.349	0.169	0.203	6.190	6.468
	200 ppm	0.333	0.353	0.179	0.212	6.247	6.576
	400 ppm	0.327	0.349	0.164	0.199	6.376	6.742
	600 ppm	0.311	0.338	0.157	0.197	6.542	6.865
Salicylic acid (SA)	0 ppm	0.331	0.353	0.174	0.204	6.302	6.624
	200 ppm	0.364	0.376	0.176	0.208	5.845	6.056
	400 ppm	0.399	0.412	0.195	0.213	4.255	4.587
	600 ppm	0.419	0.426	0.201	0.229	3.776	3.978
Gibberellic acid (GA_3)	0 ppm	0.329	0.354	0.175	0.209	6.242	6.563
	100 ppm	0.375	0.391	0.182	0.213	4.314	4.578
	200 ppm	0.403	0.432	0.197	0.232	3.783	3.863
	300 ppm	0.427	0.448	0.204	0.243	3.543	3.598
Calcium chloride ($CaCl_2$)	0 %	0.325	0.355	0.174	0.209	6.211	6.542
	0.5%	0.349	0.374	0.179	0.214	6.076	6.461
	1.0 %	0.376	0.398	0.185	0.219	4.993	5.347
	2.0 %	0.394	0.421	0.193	0.226	4.555	4.723
L. S. D 0.05		0.025	0.024	0.009	0.009	0.742	0.794
Mean effect of agro-chemicals	AsA	0.319	0.343	0.179	0.201	6.234	6.549
	CiA	0.327	0.347	0.167	0.202	6.343	6.662
	SA	0.378	0.391	0.186	0.213	5.044	5.311
	GA_3	0.383	0.406	0.189	0.224	4.471	4.650
	$CaCl_2$	0.361	0.387	0.183	0.217	5.458	5.768
L. S. D 0.05		0.012	0.012	0.005	0.005	0.369	0.396
Mean effect of concentrations	0	0.328	0.351	0.173	0.205	6.243	6.548
	Low	0.348	0.369	0.178	0.210	5.699	5.998
	Medium	0.365	0.387	0.184	0.213	5.125	5.417
	High	0.374	0.392	0.188	0.218	4.974	5.190
L. S. D 0.05		0.011	0.010	0.004	0.004	0.330	0.352

As for the interaction between the different chemicals and its concentrations, the data in Table (4) showed that citric acid at 600 ppm resulted in the highest anthocyanin content in both seasons. Meanwhile, the lowest value of anthocyanin content was attained with trees received gibberellic acid at 600 ppm in both seasons.

The increase of anthocyanin and decrease of chlorophyll a and b contents as a result of ascorbic and citric acid applications may be due to that these compounds enhanced the activity of chlorophyllase enzymes which resulted in appearance of colored pigments. Therefore, the main pigments which include anthocyanin appeared (Farag and Nagy, 2012). In addition, ascorbic acid is known to increase the rate of photochemical reduction, photosynthetic electron transfer as well as photosynthesis (Moore and Patrick, 1984). On the other contrary, it could be concluded that each of SA, GA_3 or $CaCl_2$ had the ability to delay peach fruit maturity and ripening since anthocyanin formation and its intensity are major attributes or criteria for these stages.

REFERENCES

Abd EL-Naby, S. K. M. and Nadir, A. S. (**2003**). Peach fruit quality as affected by preharvest calcium sprays. Minufiya J. Agric. Res. **28** (**1**): 311-330.

Andrews, P. K. and Li, S. L. (**1995**). Cell wall hydrolytic enzyme activity during development of non climacteric sweet cherry (*Prunus avium* L.) fruit. Journal of Horticultural Science. **70(4)**: 561-567.

Association of Official Agriculture Chemistry (A.O.A.C., **1985**). Official methods and tentative methods of analysis. 7th ed., p. 910 Washington, D.C., U.S.A.

Barandoozi, F. N. and Talaie, A. (**2009**). The effect of gibberellins on russeting in "Golden Delicious" apples. J. of Horticulture and Forestry. **1(4)**: 061-046.

Ben-Arie, R. and Ferguson, I. B. (**1991**). Ethylene production by growing and senescence pear fruit cell suspensions in response to gibberellin. Plant Physiology. **95(3)**:943-947.

Chen, B, M. and Mellenthin, W. M. (**1981**). Effect of harvest date on ripening capacity and post harvest life of Anjou pears. J. Amer. Soc. Hort. Sci. **106**: 38-42.

Elade, V. (**1992**). The use of antioxidants to control gray mould *(Botrytic cinera)* and White mould *(Sclerotinia sclerotiorom)* in various crops. Plant Pathol.**141**: 417-426.

FAO. (**2011**). Food and Agriculture Organization of the United Nations Internet site. Agricultural statistics. www.fao.org.

Farag, K. M. and Nagy, N. M. N. (**2012**). Effect of pre and post-harvest calcium and magnesium compounds and their combination treatments on "Anna" apple fruit quality and shelf life. Journal of Horticultural Science & Ornamental Plants. **4 (2)**: 155-168.

Fayed, T.A. (**2010**). Effect of some antioxidant applications on growth, yield and bunch characteristics of "Thompson Seedless" grapevine. American Eurasian, Agric& Environ. Sci. **8(3):** 322-328.

Fuleki, T. and Francis, F. J. (**1968**). Quantitative Methods for Anthocyanins. 1- Extraction and determination of total anthocyanin in cranberries. Journal of Food Science. **33**:72-77.

Glenn, G. M. and Poovahiah, B. W. (**1986**). Role of calcium in prolonging storage life of fruits and vegetables. Food Technology. **40**: 86-89.

Hafez, O. M., Hamouda, H. A. and Abd- El-Mageed, M. A. (**2010**). Effect of calcium and some antioxidants treatments on storability of "Le- Conte" pear fruits and its volatile components. Nature and Science. **8(5)**: 109-126.

Hassan, H. S. A., Sarrwy, S. M. A. and Mostafa, E. A. M. (**2010**). Effect of foliar spraying with liquid organic fertilizer, some micronutrients and gibberellins on leaf mineral content, fruit set, yield and fruit quality of “Hollywood” plum trees. Agric. Biol. J. N. Am. **1(4)**: 638-643.

Hayat, A. S. and Ahmed, A. (**2007**). Salicylic acid. A Plant Hormone. Springer ISBN. pp: 1-200.

Hussein, M. A., El-Mahdy, T. K. and Ibrahim. A. A. (**2001**). Effect of calcium chloride and gibberellic acid treatments on "Anna" and "Dorest Golden" apples during storage: B - Chemical characteristics of fruits. Assiut Journal of Agricultural Sciences. **32(2)**: 185-200.

Ismail, A. A. M. (**2006**). Effect of putrescine, gibberellic acid and calcium on quality characteristics and the delay of the ripening of "Desert Red" peach fruit cultivar. Master of Science Thesis. Faculty of Agriculture-Damanhour, Alexandria University.

Kazemi, M., Aran, M. and Zamani, S. (**2011**). Effect of salicylic acid on quality characteristics of apple fruits during storage. American Journal of Plant Physiology. **6(2)**:113-119.

Khader, S. (**1992**). Effect of gibberellic acid and vapor gard on ripening, amylase and peroxidas activities and quality of mango fruit during storage. J. Horticultural Sci. **67(6)**: 855-860.

Magness, J. R. and Taylor, G. F. (**1982**). An improved type of pressure tester for the determination of fruit maturity. USDA Cir. No. 350.

Malik, C. P. and Singh, M. B. (**1980**). Plant Enzymology and Histoenzymology. A text manual, Kalyani publishers, New Delhi. pp: 286.

Moore, T.C. (**1979**). Biochemistry and Physiology of Plant Hormones. Springer Verlage, New York, U.S.A. pp: 274.

Ozeker, E. (**2005**). Salicylic acid and its effects on plants. E.U. Faculty of Agriculture J. **42 (1)**: 213- 223.

Pila,N., Gol, N. B. and Ramana Rao, T. V. (**2010**). Effect of post harvest treatments on physicochemical characteristics and shelf life of tomato (*Lycopersicon esculentum* Mill.) fruits during storage1. American Eurasian J. Agric. & Environ. Sci. **9 (5)**: 470-479.

Ragab, M.M. (**2002**). Effect of spraying urea, ascorbic acid and NAA on fruiting of "Washington Navel" orange trees. M. Sc. Thesis. Fac. Agric. Minia. Univ. Egypt. Pathol. **141**: 417-426.

Rao, M. V., Koch, R. and Davis, K. R. (**2000**). Ozone a tool for probing programmed cell death in plants. Plant Mol. Biol. **44(3)**: 346-358.

Richard, M. (**2006**). How to grow big peaches. Dep. of Hort. Virginia Tech. Blacksburg, VA 24061. Internet, www. Rce.rutgers.edu. 8 pages, August.

Rizk-Alla, M. S., Girgis, V. H. and Abd EL-Ghany, A. A. (**2006**). Effect of foliar application of mineral or chelated calcium and magnesium on "Thompson seedless" grapevines grown in a sandy soil: B- Fruit quality and keeping quality during storage at room temperature. J. Agric. Sci. Mansoura Univ. **31 (5)**: 3079-3088.

Rohani, M. Y., Zaipun, M. Z. and Norhayati, M. (**1997**). Effect of modified atmosphere on the storage life and quality of "Eksotika" papaya. J. Trop. Agric. Food Sci. **25**: 103-113.

Samara, N. R., Mansour, A. M., Touky, M. N. and Tarabih, M. E. (**2008**). Pre and postharvest treatments on peach fruits grown under desert conditions. J. Agric. Sci. Mansoura Univ. **31(12)**: 7835-7846.

Shahin, M. F. M., Fawzi, M. I. F. and kandil E. A. (**2010**). Influence of foliar application of some nutrient (fertifol misr) and gibberellic acid on fruit set, yield, fruit quality and leaf composition of “Anna” apple trees grown in sandy soil Journal of American Science. **6(12)**: 202-208.

Sher-Mohammmad., Khalil, I. A. and Mohammad, S. (**1997**). Effect of gibberellic acid on the colour development of 'Redhaven' peaches. Sarhad Journal of Agriculture. **13(5)**:425-430.

Siddiqui, S. and Bangerth. F. (**1995**). Differential effect of calcium and strontium on flesh firmness and properties of cell walls in apples. J. Hort. Sci. **70(6)**:949-953.

Smirnoff, N. (**1996**). The function and metabolism of ascorbic acid. Plants. Ann. Bot. **87**: 661-669.

Srivastava, M. S and Dwivedi, U. N. (**2000**). Delayed ripening of banana fruit by salicylic acid. Plant Science**. 158**: 87–96.

Steel, R. G. and Torrie, J. H. (**1984**). Principles and procedures of statistics. A Biometrical Approach. 4rd ed., Mc Graw Hill. USA.

Stino, G. R., Mohsen, M. M. and Abd El- Wahab. M. A. (**2011**). Enhancing the productivity and fruit quality of "Le Conte" pear via growth regulators, nutrients and amino acids. Journal of Horticultural Science & Omamental Plants. **3(1)**:65-74.

Tareen, M. J., Abbasi, N. A. and Hafiz, I. A. (**2012**). Effect of salicylic acid treatments on storage life of peach fruits cv. ‘Flordaking’ .Pak. J. Bot. **44(1)**: 119-124.

Tobias, R. B., Conway, W. S. and Sams, C. E. (**1993**). Cell wall composition and calcium treated apples moculated with *Botrytis cinerea*. Phytochemistry. **32**: 35-39.

Wahdan, M. T., Habib, S. E., Bassal, M. A. and Qaoud, E. M. (**2011**). Effect of calcium chloride and gibberellic acid on storability of "Succary Abiad" mango fruits under cold storage .Journal of American Science. **7(5)**: 493-501.

White, P. J. and Broadly, M. R. (**2003**). Calcium in plants. Ann. Bot. **92(4)**: 487-511.

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 العربى

تأثير الرش ببعض الكيماويات الزراعيـة قبل الحصاد على انتاجية وجودة ثمار الخوخ صنف السويلنج

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أجريت هذه الدراسة خلال موسمى النمو ٢٠١٢- ٢٠١٣على أشجار عمرها ٦ سنوات لصنف الخوخ سـويلنج المنزرعة تحت ظروف الارض الرملية. لدراسة تأثير الرش بأحماض الاسكوربيك والستريك والسلسـليك بتركيـز (صفر، ٢٠٠، ٤٠٠ و ٦٠٠) جزء فى المليون وحمض الجبريلليك بتركيز (صفر، ١٠٠، ٢٠٠ و ٣٠٠) جزء فى المليون وكلوريد الكالسيوم بتركيز (٠.٥، ١ و٢%) على المحصول وجودة الثمار.

أوضحت النتائج ان الرش بحمض الجبريلليك أدى لزيادة معنوية فى المحصول مقارنـة ببـاقى الكيماويـات الزراعية فى الموسم الاول فقط بينما فى الموسم الثانى فان اضافة كلا من حمض الاسكوربيك وكلوريد الكالسـيوم أعطى اعلى محصول مقارنة بكل من حامض الستريك والسلسليك والجبريللك. حمض الجبريلليك سبب زيادة كـل من وزن وصلابة الثمار مقارنة بباقى المعاملات المستخدمة فى كلا الموسمين. أدى كلوريد الكالسـيوم وحمـض والسلسليك لزيادة الصلابة مقارنة بكل من حمض الاسكوربيك والستريك فى كلا الموسمين. أدت المعاملة بكل مـن حمض الاسكوربيك والستريك الى زيادة محتوى الثمار من المواد الصلبة الذائبة والسكريات الكلية والسكريات غير المختزلة والانثوسيانين مقارنة بباقى المعاملات فى كلا الموسمين. أدت اضافة حـامض الجبريليـك ووالسلسـليك وكلوريد الكالسيوم لزيادة الحموضة والسكريات المختزلة وكلورفيل أ وب مقارنة بكل مـن حمـض الاسـكوربيك والستريك فى كلا الموسمين. بصفة عامة توضح النتاج ان المعاملة بحمض الجبريلليك والسلسليك وكلوريد الكالسيوم أدت لزيادة مؤكدة فى المحصول وصلابة الثمار ووكلورفيل أ وب مقارنة بباقى المواد المستخدمة. أعلـى محتـوى للثمار من المواد الصلبة الذائبة والسكريات الكلية والانثوسيانين مع محصول مقبول لصنف الخوخ سويلنج قد لوحظ مع معاملتى حمض الاسكوربيك والستريك.