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Effect of Hydrogen Peroxide on the Growth, Fruit Set, Yield and Quality of Ewais Mango Trees

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THIS investigation was conducted to assess the regulatory effect of hydrogen peroxide (H_2O_2) on the growth, development, yield and fruit quality of mango cv. Ewais grown under sandy soil during 2017 and 2018 seasons. The trees received five foliar sprays of water (control), 5, 10, 20 and 50 mM H_2O_2 under field conditions. Results showed that 5mM H_2O_2 treatment has significantly increased total chlorophyll content of the leaves, fruit set / panicle, fruit retention/panicle, peel weight, pulp/fruit percentage and reduced fruit drop of the fruits of mango (*Mangifera indica linnaeus*). Using 20 mM H_2O_2 was reasonable in enhancing vegetative growth (number of leaves / shoot and leaf area), resulting in large fruit length and fruit width, increasing number of fruits/ tree,fruit weight and yield as compared with control. Regarding to fruit quality, it was observed that the application with 20 mM H_2O_2 treatment significantly improved total sugar, phenol and carotenoids content. It was concluded that spraying 5 and 20 mM H_2O_2 once a week, two times before anthesis (5th of March and 13th of March) and eight times after anthesis (from 20th of April to 15th of June)maximized the yield, productivity and fruit quality of Mango fruits under field conditions.

Keywords: Hydrogen peroxide, Mango, Growth, Development, Yield, Fruit quality.

Introduction

Mango (*Mangifera indica Linnaeus*) is one of the most important crop and finest fruits in the tropical and sub-tropical regions of the world. Low productivity, alternate bearing, prolonged juvenility and incidence of large numbers of pest and diseases are the major constraints in Ewais mango cultivation. In spite of adequate flowering,low fruit yield in mango orchards have been experienced because of low fruit set and subsequently higher fruit drop and sometimes only 0.1% of fruit set reach maturity (Chadha, 1993). There are several causes of fruit drop including, unsuitable environmental conditions, inadequate soil moisture, low photosynthetic level, mango malformation, spongy tissue and susceptibility to major diseases and pests (Bains et al., 1997 and Marcelis et al., 2004).

Therefore, any effort that is directed towards enhancing the production of mangoes trees results in a promotion in our national income. Hydrogen peroxide (H_2O_2) is found naturally in plants and it has been noted that H_2O_2 acts as a growth stimulator,terminator and also regulator of several types of plants. It was previously thought to be toxic to the cell, but increasing evidence now suggests that Hydrogen peroxide (H_2O_2) plays an essential role as a signaling molecule in numerous physiological processes, which include photosynthesis,respiration, transpiration and translocation as hydrogen peroxide is most stable Reactive Oxygen Species (ROS). Thus, these processes will result in enhancementof productivity and fruit yield (Slesak et al., 2007). H_2O_2 is an environmentally-friendly compound, where activity is based on oxidation of fungi and bacteria, meanwhile, it is beneficial as it cleans water off harmful substance such as

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spores, disease-causing organism and dead organic material , which prevents new infections from occurring Cheeseman (2006). However, increasing lines of evidence supported the idea that H_2O_2 might have a dual role in plants. At low or normal concentrations, (1- 5 mMg^{-1}Fw) it works as a messenger molecule which involves in adaptive signaling, helps fruit adapt to various environmental stressors and at high concentrations, (above 7 mMg^{-1} Fw) it arranges programmed cell death (Dat et al., 2000).

In Brassica campestris seedlings Chun-Yanl et al. (2007) found that application of H_2O_2 increased anti-oxidant levels. In addition, Khandaker et al. (2012) stated that spraying Wax apple with 5mM H_2O_2significantly improved fruit set, increased fruit size, fruit number and yield.Currently, no information is available in literature on the effect of H_2O_2on mango growth. Our research was designed to study the effect of H_2O_2 on vegetative growth, yield and fruit quality of Ewais mango trees under field conditions.

Materials and Methods

The present study was performed during two successive seasons of 2017 and 2018 on ten year-old Ewais mango trees (*Mangifera indica* L.) budded on Sukkary seedling rootstocks. Trees were spaced at 6 × 4 meters apart and grown under drip irrigation in a sandy soil at a private orchard in Edko region, El-Behera governorate. Twenty healthy trees were uniformly selected nearly in vigor, size, productivity and received the same horticulture practices. They were subjected to five foliar application treatments with 4 replicated/ treatment in a randomized complete block design (RCBD). Trees were sprayed with 5, 10, 20, 50 mM H_2O_2 and water (the control) once each week from the beginning of flower opening, through fruit development.Before spray, 10 panicles on eachexperimental tree were tagged. A total of ten spraying times were carried out, two times before anthesis (5^{th} of March and 13^{th} of March) and eight times after anthesis (from20^{th} of April to15^{th} of June).

During both seasons, the following parameters were measured:

1. Vegetative growth characters namely (number of leaves/ shoot, leaf area (cm^2)) (Ahmed and Morsy, 1999) in the spring growth.
2. Total chlorophyll (mg/ 100 g Fw) were estimated according to (von-wettstein, 1957).
3. Leaf histological study of (stomatal aperture) was done by Scanning Electron Microscope (SEM) model JSM-200 IT.
4. Fruit set/ panicle counted after 15 days of full bloom.
5. Fruit retention/ panicle recorded at mature stage (a week before harvest).
6. $\text{Fruit drop \%} = \frac{\text{Fruit set - Fruit retention}}{\text{Fruit set}} \times 100$
7. The tree yield in kg was recorded at harvest time.
8. Fruit quality: a sample of 10 of full matured fruits were taken at harvest time(August 15^{th}) from each treated tree for determination of the following physical and chemical properties, i.e., fruit weight (g), fruit length (cm), fruit width (cm), seed weight (g), peel weight (g) and pulp /fruit percentage. The total soluble solids percentage (TSS %) was measured by using Hand refractometer. Percentage of total acidity as citric acid using fresh juice with titration against 0.1 NaOH, total sugars % according to A.O.A.C. (2000). Soluble phenols % according to (Swain and Hillis (1959). Carotenoids content determined by using spectrophotometer as described by Wintermans and Mats (1965)
9. Fruit growth rate: 5 fruit were labled, the width and length were recorded periodically with a hand clipper ,on a time scale of about one week intervals starting from (first week of July) until harvest day (August, 15^{th}).

Statistical analysis

The obtained data was subjected to analysis of variance in randomized. Complete block design (RCBD) according to Snedecor and Cochran (1980). The means were compared by using the method of new least Significant differences (New L.S.D) described by (Waller and Duncan, 1969).

Results and Discussion

Vegetative growth

Data in Table (1) clearly show that spraying H_2O_2 at 5 mM had significant stimulation of shoot length, number of leaves/ shoot and leaf areain spring growth cycle rather than non application. H_2O_2 at 20 mM H_2O_2 significantly recorded the highest shoot length (17.8 and 18.3 cm) in 2017 and 2018 seasons, respectively. From the same table data stated that the all concentrations of H_2O_2

had a significant effect on the number of leaves per shoot of mango trees in the first and second seasons, compared to control. The highest numbers of leaves per shoot (12.0 and 12.0) were recorded by H_2O_2 at 20 mM H_2O_2 in 2017 and 5 mM H_2O_2 in 2018 seasons, respectively followed by 10 mM H_2O_2 while, untreated trees recorded the lowest number of leaves per shoot (9.0 and 8.5) in first and second seasons, respectively. Concerning the leaf area, 5 mM H_2O_2 and 20 mM H_2O_2 gave the highest values (77.3- 76.7) and (76.3- 77.8) in 2017 and 2018 seasons, respectively. These results coincide with the finding of Orabi et al. (2017) who suggested that the growth of cucumber plant could be improved by exogenous H_2O_2 at low concentration. Also,Watanabe et al. (2018) on lettuce leaves found that H_2O_2 treatments yielded ahigher growth rate.In addition, application with H_2O_2 might enhance cell division (Hameed et al., 2004) and secondary wall formation (Abass and Mohamed, 2011). Moreover, Goldani et al. (2012) proved that foliar application of H_2O_2 can enhance oregano shoot and root dry weight. The promoted effect of H_2O_2 on growth may be attributed to signaling by this versatile metabolite (Wahid et al., 2007 and Orabi et al., 2015). Furthermore, it could influence antioxidant enzyme and metabolic activity for the benefit of plant growth and development (Neill et al., 2002).

Total chlorophyll

The results presented in Table (1) showed that all spraying treatments with all concentrations were significantly responsible for enhancing total chlorophyll, as compared with control. The treatment with 5 mM H_2O_2 appeared healthier than those of the control and exhibited a higher total chlorophyll content (2.25 – 2.9) fold in comparison to that of untreated trees in both seasons. Similar positive effects of H_2O_2 chlorophyll content were reported by Butcher et al. (2017) in pelargonium tomentosum and Khandaker et al. (2012) in wax apple

Stomatal aperture

After studying the effect of H_2O_2 treatments on stomatal aperture. It was clear that the exogenous application of H_2O_2 significantly promoted the single stomatal opening as compared with control Fig. (1). H_2O_2 at 20 mM had the widest stomatal opening (749.1 nm) as compared with control which had the narrowest one (261.6 nm) .The other remaining treatments gave intermediate values with a significant differences among them. A heightened stomatal conductance greatly depends on the size and degree of stomatal opening. It's possible that the exogenouse application of H_2O_2 is associated with promoted stomatal conductivity and not with non-enzymatic antioxidant system Gondim et al. (2013). Moreover, Jamaludin et al. (2020) mentioned that the improved stomata conductance couldincrease net photosynthetic rates and cause greater accumulation of internal CO_2.

TABLE 1. Effect of hydrogen peroxide on vegetative growth and total chlorophyll in the leaves of Ewais mango trees during 2017 and 2018.

Treatments	Shoot length (cm)		No. of leaves/ shoot		Leaf area (cm^2)		Total chlorophyll (mg/ g F.w)	
	2017	2018	2017	2018	2017	2018	2017	2018
Control	10.0	9.7	9.0	8.5	73.2	74.2	5.3	5.5
5 mM H_2O_2	16.8	17.0	11.3	12.0	77.3	76.7	8.2	7.75
10 mM H_2O_2	15.8	16.3	10.5	11.3	75.3	75.5	7.7	7.7
20 mM H_2O_2	17.8	18.3	12.0	11.0	76.3	77.8	7.5	7.7
50 mM H_2O_2	13.3	14.5	10.0	10.5	76.0	75.8	7.9	7.8
$NewLSD_{0.05}$	**1.1**	**1.4**	**1.0**	**1.1**	**1.3**	**1.2**	**0.05**	**0.06**

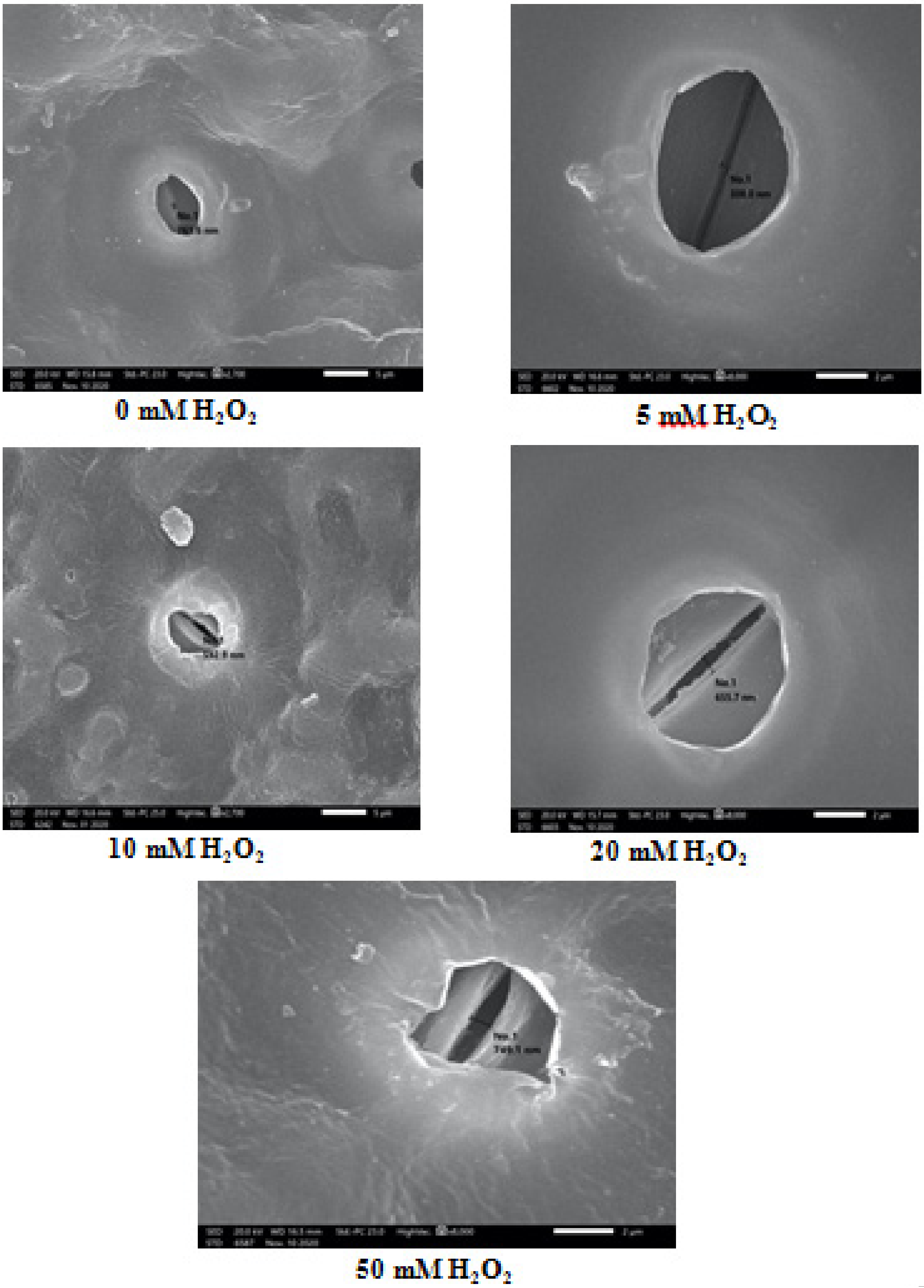

Fig. 1. Scanning Electron Microscope (SEM) photographs showing single stomatal opening of the H_2O_2 treated and untreated Ewais Mango leaves.

Fruit set/ panicle, fruit retention/Panicle and fruit drop (%)

Data in Table (2) showed that all treatments with H_2O_2 induced high positive effects on the number of fruit set / panicle as compared to the control in both seasons. The obtained results indicated that, the treatment with 5 mM H_2O_2 yielded the best number of fruit set/ panicle, however it increased almost 1.6-fold on fruit set as compared to the control, followed by treatments with 10 and 50mM H_2O_2 in two seasons.

H_2O_2 treatments significantly reduced fruit drop, in both seasons, our results revealed that the treatment with 5mM H_2O_2 had the lowest (68.3%) fruit drop, whereas the control experienced the highest (80.9%) percentage of fruit drop. Regarding fruit retention, all treatments with H_2O_2 significantly increased fruit retention. The trees treated with 5 mM H_2O_2recorded the highest number of fruit retention in both seasons (3.80 – 4.70) respectively. Also, 20 mM H_2O_2 and 10 mM H_2O_2caused a significant effect in this aspect, as compared with the control, which recorded the lowest fruit retention per panicle in both seasons. From the above results, it could be concluded that the lowest incidence of fruit drop in H_2O_2 treatments is an indication of more fruit retention and better quality. In this respect, Zhou et al. (2012) reported that hydrogen peroxide (H_2O_2) plays a crucial role in simulative reproductive growth by promoting the expression of the flower related gene, LcLFY in Litchi (Litchi Chinensis Sonn.) which inhibiting the growth of rudimentary leaves and reducing the bud drop.Also, Souza et al. (2004) reported that, treating passion fruit with H_2O_2 increased floral receptivity, which reflected on increasing fruit set and fruit retention. Ozaki et al. (2009), indicated that the enhancement in fruit set % might be explained as a result to involvement of H_2O_2 in many development processes in plants, nevertheless, it can act an important role in fruit set and fruit drop with ultimately increased the fruit retention. The above mentioned results are in accordance with those obtained by Khandaker et al. (2012) who indicated that spraying wax apple trees with 5 mM H_2O_2 increased fruit set and reduced fruit drop, followed by 20 and 50 mM H_2O_2 treatments.

Number of fruits/ tree

Table (3) reveals that all tested treatments excreted a higher number of fruits per tree as compared with untreated control. Generally, 20 mM H_2O_2 treatment proved to be the superior treatment in this aspect,as compared with the control which recorded the lowest number of fruits in both seasons. The results agree with Khandaker et al. (2012).

Yield (kg/ tree)

It is clear from data in Table (3) that all treatments significantly increased yield (kg/ tree), than the control in both seasons. Briefly, the treatment with 20 mM H_2O_2 scored almost 1.5 times higher than that of the control, producing the highest yield weight (67.9 and 69.3 kg/ tree) in 2017 and 2018 seasons, respectively. However, the control trees gave the lowest yield weight (44.54 and 47.23 kg/ tree) in the first and second seasons, respectively. While, the other remaining treatments gave intermediate values in the yield as kg/ tree.

TABLE 2. The effect of hydrogen peroxide on fruit setting as well as fruit drop and retention of Ewais mango trees during 2017 and 2018.

Treatments	fruits set/ panicle		Fruit drop (%)		Fruit retention/ panicle	
	2017	2018	2017	2018	2017	2018
Control	8.53	8.90	84.40	80.90	1.33	1.70
5 mM H_2O_2	13.17	14.80	71.7	68.3	3.80	4.70
10 mM H_2O_2	12.80	14.03	42.73	40.27	3.50	4.17
20 mM H_2O_2	11.77	13.03	73.23	70.9	3.60	3.80
50 mM H_2O_2	12.50	13.27	71.10	70.60	3.15	3.90
NewLSD$_{0.05}$	**0.92**	**0.82**	**1.58**	**1.85**	**0.41**	**0.5**

TABLE 3. Effect of hydrogen peroxide on the yield and some physical propertiesof Ewais mango fruits during 2017 and 2018.

Treatments	No. of fruits/ tree		Yield (kg/ tree)		Fruit weight (g)		Fruit length (cm)		Fruit width (cm)	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Control	196.9	200.5	44.54	47.23	225.9	235.47	9.06	8.57	5.8	6.0
5 mM H_2O_2	204.77	207.87	50.0	51.87	244.3	249.3	10.6	11.27	8.06	8.12
10mM H_2O_2	231.0	245.17	56.41	61.83	244.17	252.2	11.03	12.2	8.27	8.8
20mM H_2O_2	269.12	268.77	67.9	69.3	252.57	257.8	12.0	12.87	9.90	9.7
50mM H_2O_2	230.03	240.5	54.63	58.87	237.5	244.87	12.5	12.03	8.30	8.4
NewLSD$_{0.05}$	**6.39**	**6.04**	**1.76**	**1.94**	**5.17**	**3.94**	**0.36**	**0.39**	**0.53**	**0.32**

The enhanced effect of H_2O_2 treatments on fruit yield may be explained by the positive effect of H_2O_2 on fruit set, fruit retention and reducing fruit drop. The above mentioned results are in harmony with thosefound by Shin et al. (1998) who showed that foliar application of H_2O_2 improved the yield in melon fruits due to an increase in photosynthetic activity in leaves during CO_2 enrichment condition. Moreover, Hameed et al. (2004) stated that the treatment with H_2O_2 provided a more vigorous root system in wheat, which can be used to increase nitrogen uptake, resulting in better growth and yield (Liao et al., 2004).

Fruit quality

Fruit physical properties

Fruit weight

Fruit weight was recorded and presented in Table (3). Results revealed that various treatments of H_2O_2 had a significant effect on fruit weight, in both seasons. Generally, 20 mM H_2O_2 treatment produced the heaviest fruit 252.57 and 257.8 g against 225.9 and 235.47 g for the control treatment in 2017 and 2018 seasons, respectively. Our results agree with Bhattarai et al. (2004) who found an increase in the biomass of soybean and cotton after adding H_2O_2, through the irrigation water.

Fruit length, width and fruit growth

The effect of the different treatments on fruit length and fruit width in both seasons is presented in Table (3).

Data obtained in the first season showed that foliar spray with 50 mM H_2O_2 significantly increased fruit length (12.5), as compared with control (9.06 cm). However, in the second season, 20 mM H_2O_2 increased fruit length (12.87 cm) in comparison with control (8.57 cm). As for fruit width, the obtained data showed that all tested treatments induced a higher pronounced effect on fruit width, as compared with the control treatment in both seasons. Generally, treatment with 20 mM H_2O_2 exerted high positive effect and recorded (9.90 and 9.70 cm) against (5.8 and 6.0 cm) for control treatment in 2017 and 2018 seasons, respectively.

Concerning fruit growth, the data presented in Fig. (2 and 3) showed that all H_2O_2 treatments exerted a higher fruit growth according to the change in fruit length and fruit width from 1st week to the 10th week, after fruit set, and through the developmental period of fruit until harvest. Based on these results, it can be noticed that all fruits treated with H_2O_2 grew at a faster rate and were larger than the control fruits. In addition, from the 3rd to 7th weeks after fruit set, the fruit growth as fruit length and fruit width showed significant differences among treatments and control in both seasons. The positive effects of hydrogen peroxide on mango fruit growth (length and width) might be due to the enhanced cellular development during initial cell division at phase I or modulate cell expansion at phase II by its cell wall looseningeffect (Geros et al., 2012). The results agree with Bryce et al. (1982) who stated that H_2O_2 treatment with irrigation water increased tomato fruit size. Recently, it was reported that the application of H_2O_2 produced larger fruit size of wax apple (Khandaker et al., 2018).

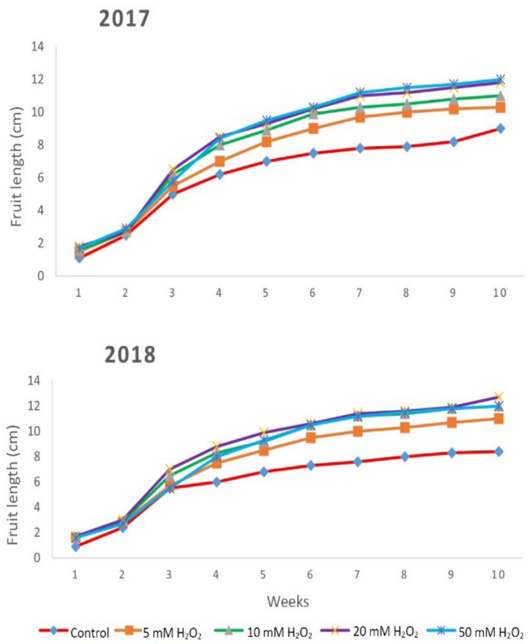

Fig. 2. The effect of Hydrogen Peroxide treatments on fruit growth according to fruit length (cm) of mango cv. Ewais in 2017 and 2018 season.

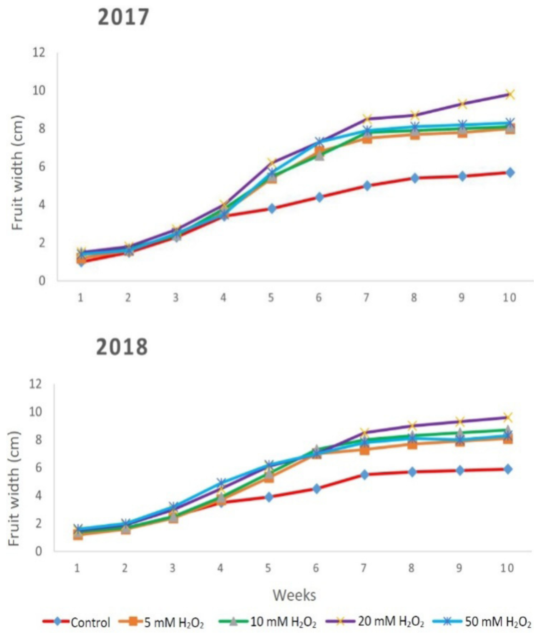

Fig. 3. The effect of Hydrogen Peroxide treatments on fruit growth according to fruit width (cm) of mango cv. Ewais in 2017 and 2018 season

Seed and peel weight and pulp/fruit (%)

The data presented in Table (4) revealed that all spraying treatments markedly increased fruit peel weight and pulp/ fruit (%) than the control in both seasons. In this respect,trees sprayed with 5 mM H_2O_2 followed by 20 mM H_2O_2 and 10 mM H_2O_2 recorded the highest values in these parameters. However, results obtained in both seasons showed that fruit seed weight was not significantly affected by any of the spraying treatments. Similar as above, Ozaki et al. (2009) on melon, they found that foliar sprays of H_2O_2 improved the physical properties through the accumulation of carbohydrates in the leaves.

Fruit chemical properties

Fruit total sugars (%)

The data listed in Table (5) showed that the trees treated with 20 mM H_2O_2 gave the highest percent of fruit total sugars (14.4 and 14.8%) in 2017 and 2018 seasons, respectively.

Likewise, treatments with 10 mM H_2O_2 and 5 mM H_2O_2 also caused higher values of total sugars as compared with control, which gave the lowest values (9.06 and 9.20 %) in 2017 and 2018 seasons, respectively. The increase of fruit sugars, as a result of tested treatments, may be attributed to the effect of hydrogen peroxide on increasing leaf area, which reflected in more carbohydrate production through the photosynthesis process and reflected on improvement of fruit chemical properties. The above mentioned results are in accordance with those found by Peng et al. (2005), and Shin et al. (1998) observed that increased photosynthetic activity in melon leaves enhanced yield and soluble sugar content in fruits. Furthermore, Jamaluddin et al. (2020)showed that spraying of H_2O_2 significantly improved the stomata sizes and density all both surfaces of leaves, which was associated with improved gas exchange or stomatal conductance. Asis well known, stomatal conductance affects the photosynthetic rate by regulating CO_2 fixation in the leaf and is positively correlated with photosynthesis. Subsequently, after photosynthesis, sugars, namely sucrose, are exported from the source leaves to other plant parts. Also, Ozaki et al. (2009) mentioned similar positive role of H_2O_2 on photosynthesis in melon plant and suggested that 20 mM H_2O_2 increased the endogenous H_2O_2 level, which acts as the signal transduction of soluble sugar content in leaves and fruits.This enhancement could possibly be due to the effects of exogenous H_2O_2, as it stimulates the sucrose phosphate synthase (sps)enzyme,which regulates the formation of sucrose from triose phosphates during and after photosynthesis in rice (Uchida et al., 2002).

Total soluble solids (%)

The results pertaining to TSS of fruits, as affected by different hydrogen peroxide treatments, are presented in Table (5). The results obtained in this regard were significant. The maximum TSS of mango fruits (19.2and 19.5 %) was noticed with treatment of 20 mM H_2O_2, which was significantly superior over control (14.6 and 15.3 %) in 2017 and 2018 seasons, respectively. The increase in the TSS by hydrogen peroxide might due to rapid translocation of sugars from the leaves to the developing fruits. The results may confirm the previous work done by Ozaki et al. (2009) and Tehrani et al. (2011) in wax apple and Shin et al. (1998) in melon.

Acidity (%)

Data in Table (5) illustrated that all treatments with H_2O_2 gave high reductive effect on fruit acidity (%) as compared with control in both seasons. Briefly, 20 mM H_2O_2 and 50 mM H_2O_2 recorded the lowest values in fruit acidity (0.26, 0.23 and 0.24, 0.25 %) in 2017 and 2018 seasons, respectively. On the other hand, the highest fruit acidity (%) in the control treatments (0.52 and 0.55 %) in 2017 and 2018 seasons, respectively.

Total phenolic

Results in Table (5) revealed that all tested treatments had a significant effect on the total phenolic content as compared with the control in 2017 and 2018 seasons, Generally, 20 mM H_2O_2 treatment exhibited the highest content of phenol (1.13 and 1.1 %) in 2017 and 2018 seasons, respectively, followed by 50 mM and 10 mM H_2O_2, however, the control gave the lowest content of phenol (0.48 and 0.49) in 2017 and 2018 seasons, respectively.The reason why the phenolic acid increased could be due to the involvement of H_2O_2as a signal molecule in phenolic synthesis. These results are in concordance with those obtained by Nyathi and Baker (2006) who observed that H_2O_2 might be responsible for activating gene expression of PAL, CHS and stylbene synthase enzymes, which are related with synthesis and accumulation of the metabolites phenols.

TABLE 4. The effect of hydrogen peroxide on some physical properties of Ewais mangofruit during 2017 and 2018.

Treatments	Seed weight (g)		Peel weight (g)		Pulp/ fruit (%)	
	2017	2018	2017	2018	2017	2018
Control	10.9	10.8	17.45	16.25	71.65	72.95
5 mM H_2O_2	9.9	10.3	15.80	15.30	73.9	74.1
10 mM H_2O_2	10.8	11.0	16.20	15.80	73.0	73.2
20 mM H_2O_2	10.0	10.2	15.90	16.30	73.9	73.2
50 mM H_2O_2	10.6	10.4	17.0	16.20	72.4	73.4
NewLSD$_{0.05}$	**1.1**	**0.85**	**0.25**	**0.18**	**1.2**	**1.1**

TABLE 5. The effect of hydrogen peroxide on some chemical properties of Ewais mango fruit during 2017 and 2018.

Treatments	Total sugars %		T.S.S. (%)		Acidity (%)		Total phenols (%)		Total carotenoids (mg/ g F.w)	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Control	9.06	9.2	14.6	15.3	0.52	0.55	0.48	0.49	2.40	2.10
5 mM H_2O_2	12.7	11.9	16.2	16.7	0.32	0.37	0.62	0.68	4.2	3.8
10 mM H_2O_2	13.6	12.8	18.0	18.7	0.3	0.28	0.80	0.81	3.0	2.85
20 mM H_2O_2	14.4	14.	19.2	19.5	0.26	0.23	1.13	1.1	4.60	4.3
50 mM H_2O_2	11.48	11.7	16.8	17.2	0.24	0.25	0.97	0.86	3.18	3.6
NewLSD$_{0.05}$	**0.55**	**0.44**	**0.74**	**0.40**	**0.04**	**0.03**	**0.2**	**0.98**	**0.50**	**0.40**

Total carotenoids

Results in Table (5) showed that treatments with H_2O_2 exerted higher positive effects on total carotenoids (mg/ 100 g. Fw) contents as compared with control. During 2017 and 2018 seasons the highest carotenoid content was found in the 20 mM H_2O_2 (4.60 and 4.30 mg/ 100 g. Fw), respectively, followed by 5 and 50 mM H_2O_2, whereas, the lowest value of carotenoids content (2.40 and 2.10 mg/ 100 g. Fw) in 2017 and 2018 seasons, respectively, was found in control fruits. The increase in carotenoid content in mango may be due to the role of H_2O_2 in the accumulation of fruit pigments in these fruits (Khandaker et al., 2012). Similarly, Kobayashi et al. (1993), suggested that carotenoid biosynthesis was enhanced by H_2O_2 and other active oxygen species in *Haemato coccuspluvialis* without *de novo* protein synthesis.On the other hand,these results were opposing to a study carried by Kim et al.(2007),who reported that higher concentrations of H_2O_2(100 mM to 400 mM) on tomato, reduced carotenoid content, which caused it to undergo color changes.

Conclusion

Considering the previous results, it seems pertinent to indicate that ten spraying times of 5mM and 20mM hydrogen peroxide once a week, two times before anthesis (5th of March and 13thof March) and eight times after anthesis (from 20th of April to 15th of June) was beneficial for improving growth,productivity and fruit quality of Ewais mango (*Mangifera indica linnaeus*) trees under field conditions.

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Conflicts of interest

The author declares that there are no conflicts of interest related to the publication of this study.

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تأثير فوق اكسيد الهيدروجين على النمو والعقد والمحصول وجودة الثمارفى اشجارالمانجو صنف عويس

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أجريت هذه الدراسة خلال عامى ٢٠١٧-٢٠١٨ على اشجار المانجو صنف عويس عمرها ١٠ سنوات مطعومة على اصل السكرى فى احدى المزارع الخاصة بمنطقة ادكو –محافظة البحيرة ومنزرعة فى تربة رملية على مسافات ٤×٦ولقد تم رش الأشجار(٠-٥-١٠-٢٠-٥٠) ملليمول من فوق أكسيد الهيدروجين مرة أسبوعيا من بداية تفتح الأزهار حتى نمو الثمار وذلك لدراسة تأثير فوق أكسيد الهيدروجين على النمو والعقد والمحصول وجودة ثمار المانجو صنف عويس.

أوضحت النتائج أن المعاملة ٥ملليمول من فوق اكسيد الهيدروجين ادت الى زيادة محتوى الاوراق من الكلوروفيل وعدد الثمار العاقدة والمتبقية ووزن القشرة ونسبة اللب للثمار وكذلك ادى الى تقليل التساقط فى الثمار .ايضا اظهرت النتائج ان المعاملة ب ٢٠ ملليمول من فوق اكسيد الهيدروجين حسنت من النمو الخضرى من حيث زيادة عدد الاوراق /فرع وكذلك زيادة المساحة الورقية وايضا ادى الى زيادة زيادة طول وقطر ووزن الثمرة و عدد الثمار للشجرة وبالتالى زيادة المحصول بالمقارنة بالكنترول.كذلك ادت المعاملة ٢٠ ملليمول من فوق اكسيد الهيدروجين الى زيادة محتوى الثمار من السكريات الكلية والفينولات والكاروتينات.