

## Effect of Some Growth Regulators and Antioxidants Sprays on Productivity and Some Fruit Quality of Zaghloul Date Palm

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**Abstract:** An experiment was conducted to evaluate the effect of some growth regulators (NAA at 25 ppm and GA<sub>3</sub> at 50 ppm) and antioxidants (salyslic acid at 1000 ppm and citric acid at 1000ppm) and their combinations on fruit set, yield and fruit quality of Zaghloul date palm.

Generally, spraying bunches of date palm with the mixture of GA<sub>3</sub> at 50 ppm + salicylic acid (SA) at 1000 ppm significantly increased fruit retention, bunch weight, fruit weight, fruit size and fruit length, total soluble solids and total sugars, also decreased tannins in the fruits as compared with other treatments including the untreated bunches in both seasons of the study.

**Key words:** Date palm, Fruit quality, Plant growth regulators, Antioxidants.

### Introduction

Date palm (*Phoenix dactylifera* L.) is one of the ancient domestic fruit crops in the Middle East countries; its fruits play an important role in the nutrition pattern of many people. It plays an important role in the economic and social life of the people of these regions. The total production of date fruits in Egypt is about 1.3 million tons<sup>1</sup>. In Egypt, many cultivars are grown in different regions according to the diversity of their climatic necessity, particularly average temperature and relative humidity that affect fruit growth and development.

Bunch and fresh weight per fruit were increased with GA<sub>3</sub> application for Zaghloul date cultivar, also percentage of seeds was decreased as the concentration of GA<sub>3</sub> increased<sup>2</sup>. Similarly, GA<sub>3</sub> application increased fruit weight and size compared with the untreated fruits for Samani dates<sup>3</sup>. Also, fruit weight, volume, length, diameter, soluble solids and total sugars of Zaghloul and Samani dates were generally increased by GA<sub>3</sub> treatments at 100-250ppm<sup>4</sup>.

Synthetic auxins are effective on enhancing fruit growth<sup>5</sup>. These auxins are known by their ability to increase the cell size<sup>5-7</sup> and enhance fruit growth of Clementine<sup>8</sup>, date palm<sup>9-12</sup>.

Application of naphthalene acetic acid (NAA) between 50 to 200 ppm concentrations during the depressed period of fruit growth caused an increase in fruit size and weight and improved fruit quality in Zahdi, Sayer and Khemazi cvs<sup>9,11</sup>; in Barhee cv.<sup>10</sup> and in Khadrawy cv.<sup>10</sup> and Shahani cv.<sup>13</sup>.

Antioxidants such as organic acids, amino acids and vitamins may play a definite role in solving the problem of poor yielding through enhancing growth, nutritional statues, yield and fruit quality in different evergreen fruit crops namely date palms, citrus, mangoes, bananas and olives<sup>14-18</sup>.

These positive action surely reflected in enhancing growth, nutritional states and yield quantitatively and qualitatively<sup>14, 19-22</sup>.

The objective of this study were to assess relative effectiveness of some growth regulators such as gibberlic acid and Naphthalene acetic acid and two antioxidants namely salicylic acid and citric acid and their combinations on fruit set yield and fruit physiochemical properties, yield of Zaghoul date palm.

## Materials and Methods

This study was carried out during two successive growing seasons (2012 and 2013) at a private orchard at Wadi El-Molak region Ismailia governorate, Egypt, to study the effect of some growth regulators, i.e. naphthalen acetic acid (NAA), gibberlic acid (GA<sub>3</sub>) and some antioxidants, i.e. salicylic acid and citric acid on fruit set, yield and fruit quality of Zaghoul date palm.

Forty female Zaghoul palms (10 years old) uniform in growth, free from insects damage and diseases were selected and subjected to the same management and practices. The trees were planted at 7x 7 m apart.

Ten foliar application treatments were arranged in a randomized complete block design with four replicates (1 replicate = 1 palm) per treatment (i.e. 10x4x1 = 40 palms). The ten foliar spraying treatments were as follows:

- T1: Control (treated with water only)
- T2: NAA at 50 ppm
- T3: GA<sub>3</sub> at 50 ppm
- T4: Salicylic acid (SA) at 1000 ppm
- T5: Citric acid (CA) at 1000 ppm
- T6: NAA at 50 ppm +SA at 1000 ppm
- T7: NAA at 50 ppm +CA at 1000 ppm
- T8: GA<sub>3</sub> at 50 ppm +SA at 1000 ppm
- T9: GA<sub>3</sub> at 50ppm +CA at 1000 ppm
- T10: SA+CA at 1000 ppm.

All treatments were sprayed one week after pollination (1<sup>st</sup> week in April). Sprays were applied by small hand gun sprayer until run-off. Wetting agent Tween 20 (1%) was applied with spraying solution.

The following measurements were carried out:

### 1. Fruit set:

During the last week of June in each season fruit set percentage was determined using the following formula:

$$\text{Fruit set \%} = \frac{\text{Number of fruits setting on the strand}}{\text{Total number of flowers per stand}} \times 100$$

### 2. Fruit retained percentage:

It was calculated using the formula of:-

$$\text{Fruit retention (\%)} = \frac{\text{Number of retained fruits}}{\text{Number of retained of fruit+ number of flower scars}} \times 100$$

### 3. Yield / palm (kg)

At harvesting (mid of September in both seasons), bunches of dates were weighted, then multiplied by the number of bunches/palm to obtain the total yield/palm.

#### 4 Fruit physical properties :

Samples of 30 fruits per each palm (10 fruits from each bunch (as a replicate) were taken randomly to determine fruit weight, flesh weight, seed weight (g) fruit dimensions (length and diameter (mm) and fruit size (cm<sup>3</sup>). Flesh fruit ratio: It was calculated by dividing fruit flesh weight on fruit weight.

#### 5 Fruit chemical properties:

- Total soluble solids (TSS %): TSS % was determined in fruit flesh juice by using Carl-Zeiss hand refractometer<sup>23</sup>.
- Fruit acidity (%): Fruit acidity was determined as malic acid in the fruits with titration against 0.1 NaOH<sup>23</sup>.
- TSS/acid ratio (%): It was calculated by dividing TSS on total acidity values of fruit juice.
- Total, reducing and non-reducing sugars: They were determined as fresh weight according to the method described by Smith *et al.* (1956)<sup>24</sup>.
- Tannins: they were determined according to the Folin-Denis method described by Schanderl (1970)<sup>25</sup>.

#### Statistical analysis

The data were subjected to the statistical analysis of variance and means separation was done according to Duncan (1955)<sup>26</sup> at 5 % level.

### Results and Discussion

#### Fruit set, fruit retention and bunch weight:

Results presented in Table (1) show fruit set, fruit retention (%) and average bunch weight of Zaghloul date palm as affected by different spraying treatments in both seasons.

Regarding fruit set , data in Table (1) showed that, fruit set was significantly increased with the mixture of GA<sub>3</sub> +SA and recorded the highest fruit set (51.0 and 58.50 %) in the 1<sup>st</sup> and 2<sup>nd</sup> seasons respectively, without significant differences between this treatment and the mixture of GA<sub>3</sub> +CA in the second season. On the other hand, control treatment recorded the lowest values (14.70 and 16.42) % in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively.

**Table (1): Effect of some foliar spray treatments on fruit set, fruit retention and bunch weight of Zaghloul date palm**

Treatments	Fruit set (%)		Fruit retention (%)		Bunch weight (kg)	
	1 <sup>st</sup> season	2 <sup>nd</sup> season	1 <sup>st</sup> season	2 <sup>nd</sup> season	1 <sup>st</sup> season	2 <sup>nd</sup> season
T1	14.70 f	16.42 f	6.00 f	8.00 f	7.15 h	7.00 h
T2	15.55 f	31.42 d	9.00 e	10.00 e	8.00 g	8.00 g
T3	37.50 d	31.25 d	15.00 d	18.00 c	8.00 g	9.00 f
T4	33.33 e	36.73 c	17.00 cd	18.00 c	14.00e	14.00 d
T5	45.00 c	56.41 b	18.00 bc	20.00 b	11.00 f	12.00 e
T6	44.00 c	28.50 e	18.00 bc	18.50 c	14.50de	14.50 cd
T7	44.00 c	29.00 e	18.00 bc	17.00 d	15.00 cd	14.50 cd
T8	51.00 a	58.50 a	21.00 a	22.50 a	16.50 a	16.00 a
T9	48.00 b	58.00 a	19.00 ac	20.50 b	16.00 ab	15.00 bc
T10	50.00 a	57.10 b	20.00 ab	21.80 a	15.50 bc	15.50 ab

As for fruit retention (%), bunches sprayed with the mixture of GA<sub>3</sub> plus salicylic acid (SA) recorded significant increases in fruit retention (21.0 and 22.50 %) in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively, without significant differences between the mixture of GA<sub>3</sub> plus citric acid (CA) or SA +CA. Control treatment recorded the lowest fruit retention values (6.00 and 8.00 %) in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively.

The obtained results concerning the effect of NAA and GA<sub>3</sub> are confirmed with those obtained on date palm since the application of growth regulators, i.e., 2,4-D and GA<sub>3</sub> at both rates of 100 or 150 ppm significantly decreased fruit drop of palm, while NAA had the least effect in this respect<sup>27-28</sup>.

#### Average bunch weight:

Concerning the average of bunch weight (Table1) indicated that, all treatments gave significant increases concerning bunch weight comparing with the control treatment. Treated palms with the mixture of GA<sub>3</sub>+SA produced the heaviest bunch weight (16.50 and 16.00 kg/ bunch) without significant differences than the mixture of GA<sub>3</sub>+CA in the 1<sup>st</sup> season and than the mixture of SA+ CA of each in the 2<sup>nd</sup> season. On the other hand, the lowest values were obtained with control treatment (7.15 and 7.00 kg/ bunch) in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively.

Salicylic and citric acids as an organic antioxidant compounds have an auxinic action. They provided disease control, synergetic effect on rooting and improving growth, flowering, yield and fruit quality of fruit crops<sup>29</sup>.

Results agree with those on bunch weight of date palm regarding the effect of growth regulators<sup>2-3</sup> and on Balady orange trees regarding antioxidants effect on fruit weight<sup>14</sup>.

#### Fruit size:

Results presented in Table (2) clearly indicate that fruit size of Zaghoul cultivar was significantly affected by different treatments in both seasons. It is clearly noticed that spraying bunches with the mixture of GA<sub>3</sub>+SA or GA<sub>3</sub>+CA and SA+ CA each of them gave a significant increment than the other treatments in both seasons. The highest value of fruit volume was obtained from the mixture of GA<sub>3</sub> + SA (25.0 and 22.0 cm<sup>3</sup>) in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. On the other hand, spraying bunches with NAA or untreated bunches recorded lower fruit size in both seasons.

The improving effect of antioxidants on growth parameters could be attributed to their positive action on enhancing cell division, and cell protection from free radicals that responsible of plant senescence<sup>30</sup>.

**Table (2): Effect of some foliar spray treatments on fruit size and dimensions of Zaghoul date palm**

Treatments	Fruit size (cm <sup>3</sup> )		Fruit length (cm)		Fruit diameter (cm)		Fruit shape index	
	1 <sup>st</sup> season	2 <sup>nd</sup> season	1 <sup>st</sup> season	2 <sup>nd</sup> season	1 <sup>st</sup> season	2 <sup>nd</sup> season	1 <sup>st</sup> season	2 <sup>nd</sup> season
T1	13.50 f	13.50 e	5.15 cd	5.47 bd	2.40 e	2.60 a	2.15 a	2.18 a
T2	14.00 f	13.50 e	5.14 d	5.23 e	2.50de	2.47 a	2.11 a	2.12 a
T3	13.00 f	12.00 f	5.32 c	5.25 e	2.57 ce	2.60 a	2.07 a	2.02 a
T4	23.00 bc	20.00 c	5.60 b	5.30 de	2.75ad	2.70 a	2.04 a	1.96 a
T5	17.30 e	16.50 d	5.66 ab	5.50 ad	2.60 ce	2.68 a	2.18 a	2.05 a
T6	19.00 d	20.50bc	5.60 b	5.40 de	2.62ce	2.45 a	2.14 a	2.20 a
T7	22.00 c	21.00 ac	5.65 ab	5.42 ce	2.64be	2.52 a	2.14 a	2.15 a
T8	25.00 a	22.00 a	5.78 a	5.70 a	2.98 a	2.73 a	1.94 a	2.09 a
T9	24.00 ab	21.50ab	5.74 ab	5.65 ab	2.90 ab	2.70 a	1.98 a	2.09 a
T10	23.50 a-c	21.00 ac	5.72 ab	5.62 ac	2.84 ac	2.70 a	2.01 a	2.08 a

#### Physical properties:

##### Fruit dimensions:

Results in Table (2) indicate that, different treatments had a significant effect on fruit length and diameter of Zaghoul date palm fruits in both seasons, except fruit diameter in the second one. Spraying bunches with the mixture of GA<sub>3</sub> + SA recorded the maximum values (5.78 and 5.70 cm) for fruit length and fruit diameter (2.98 and 2.73cm) in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively without significant differences than the mixture of GA<sub>3</sub> + CA and the mixture of SA+ CA in both seasons.

Respecting fruit shape index, results show that, the treatments had no significant effect on this parameter in both seasons.

The obtained concerning fruit dimensions could be attributed to the effects of gibberellic acid on growth as it stimulated both cell division and cell enlargement. Similar observation was reported by many investigators who found that fruit dimensions were increased when fruits received gibberellic acid<sup>4, 31-32</sup>.

### **Fruit flesh, seed weight and flesh/ fruit ratio**

Results presented in Table (3) indicate that spraying bunches with different treatments had a significant effect on the average of fruit weight and flesh weight of Zaghloul date palm in both seasons. Foliar spray with the mixture of GA<sub>3</sub> + SA recorded the maximum values of fruit weight (25.50 and 21.50 g) and flesh weight (23.00 and 20.00 g) in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. On the other hand, the lowest values of fruit weight (17.50 and 17.10 g) and flesh weight (15.50 and 16.50 g) were obtained with the control treatment in both seasons.

Respecting seed weight, results indicate that, in the 1<sup>st</sup> season, foliar spray with the mixture of NAA + CA recorded the maximum value (2.50 g) without significant differences than the mixture of GA<sub>3</sub> +SA or SA+ CA. In the 2<sup>nd</sup> season, foliar spray with CA alone gave the maximum seed weight (3.00 g) without significant differences than the mixture of NAA + CA.

As for flesh fruit ratio, results show that, GA<sub>3</sub>+CA treatment in the first season and control treatment recorded the highest values of flesh fruit ratio (0.94 and 0.96 ), respectively.

These results are in harmony with those recorded on date palms since spraying GA<sub>3</sub> increased average bunch weight, average fruit weight, flesh weight, fruit length and fruit diameter<sup>10, 11, 27, 33, 34</sup>.

In this regard foliar application of antioxidants on date palm improved fruit weight and dimensions (length and width), pulp %, pulp/ seeds<sup>14, 35</sup>.

**Table (3): Effect of some foliar spray treatments on fruit physical properties of Zaghloul date palm**

Treatments	Fruit weight (g)		Flesh weight (g)		Seed weight (g)		Flesh fruit ratio	
	1 <sup>st</sup> season	2 <sup>nd</sup> season	1 <sup>st</sup> season	2 <sup>nd</sup> season	1 <sup>st</sup> season	2 <sup>nd</sup> season	1 <sup>st</sup> season	2 <sup>nd</sup> season
T1	17.50 e	17.10 g	15.50 e	16.50 f	2.00 b	0.60 c	0.89 ef	0.96a
T2	19.00 d	19.00 e	17.50 d	18.40d	1.50 c	1.50 bc	0.92 bc	0.92ab
T3	18.00 e	18.50 f	16.00 e	17.00ef	2.00 b	1.50 bc	0.89ef	0.92ab
T4	23.00 b	20.50 d	21.00 bc	18.50 d	2.00 b	2.00 b	0.91cd	0.90b
T5	19.50 d	20.50 d	17.50 d	17.50 e	2.00 b	3.00 a	0.90 de	0.85c
T6	21.50 c	20.80 cd	20.00 c	19.10 bd	1.50 c	1.70 b	0.93 ab	0.92 ab
T7	21.00 c	20.90 cd	18.50 d	18.70 cd	2.50 a	2.20 ab	0.88 f	0.89 bc
T8	25.50 a	21.50 a	23.00 a	20.00 a	2.50 a	1.50 bc	0.90de	0.93 ab
T9	23.50 b	21.40 ab	22.00 ab	19.60ab	1.50 c	1.80 b	0.94a	0.92 ab
T10	23.40 b	21.00 bc	21.00 bc	19.40 a-c	2.40 a	1.60 b	0.90de	0.92 ab

### **Chemical properties:**

#### **Total soluble solids (TSS %), acidity and TSS/acid ratio**

Results presented in Table (4) show that foliar spray treatments caused a significant effect on total soluble solids during the two seasons.

The highest content of total soluble solids in fruits (35.00 and 31.20) was obtained with the mixture of GA<sub>3</sub> +SA (in the 1<sup>st</sup> and 2<sup>nd</sup> seasons without significant differences than the mixture of SA + CA in the 2<sup>nd</sup> season. While as the lowest value was obtained with the foliar spray with NAA (23.00 and 22.00) in the 1<sup>st</sup> and 2<sup>nd</sup> seasons.

As for total acidity, results in Table (4) indicate that total fruit acidity percentage was significantly affected by different treatments. Generally, foliar spray with CA gave the highest fruit acidity percentage (0.40 and 0.30) in the 1<sup>st</sup> and 2<sup>nd</sup> seasons.

Concerning TSS/acid ratio, the results in Table (4), showed that, foliar spray with the mixture of NAA + CA or the mixture of NAA +SA significantly increased TSS/ acid ratio in the 1<sup>st</sup> season since they recorded 172.60 and 161.00, respectively.

**Table (4): Effect of some foliar spray treatments on fruit chemical characteristics on Zaghoul date palm**

Treatments	TSS %		Acidity %		TSS/acid ratio	
	1 <sup>st</sup> season	2 <sup>nd</sup> season	1 <sup>st</sup> season	2 <sup>nd</sup> season	1 <sup>st</sup> season	2 <sup>nd</sup> season
T1	27.40 d	26.50 f	0.21 d	0.30 a	130.50 b	88.30 c
T2	23.00 e	22.00 h	0.20 d	0.20 c	115.00 cd	110.00 b
T3	24.00 e	26.50 f	0.30 b	0.20 c	80.00 e	132.50 a
T4	32.40 bc	29.40 c	0.30 b	0.20 c	108.00 d	147.00 a
T5	27.30 d	25.60 g	0.40 a	0.30 a	68.30 e	85.30 c
T6	32.20 bc	28.50 e	0.20 d	0.27 ab	161.00 a	110.63 b
T7	32.80 b	29.00 d	0.19 d	0.26 b	172.60 a	111.50 b
T8	35.00 a	31.20 a	0.28 bc	0.28 ab	127.77 bc	111.40 b
T9	33.20 b	30.00 b	0.29 bc	0.26 b	114.50 cd	115.40 b
T10	31.30 c	31.00 a	0.27 c	0.27 ab	115.90 cd	114.80 b

#### Sugars and Tannins percentage:

Reducing sugars percentage was significantly affected by different foliar spray treatments in both seasons (Table 5). Foliar spray of bunches with the mixture of GA<sub>3</sub> +SA or GA<sub>3</sub> + CA recorded higher reducing sugars values (60.30 and 60.90 %) and (60.30 and 60.20 %) in both seasons, respectively.

Concerning non-reducing sugars percentage, results in Table (5) indicate that fruit content of non-reducing sugars was affected significantly by different treatments in both seasons. Foliar spray with the mixture of GA<sub>3</sub> +SA gave the highest content of non-reducing sugars (8.70 %) in the 1<sup>st</sup> season without significant differences than foliar spray with GA<sub>3</sub> alone. In the 2<sup>nd</sup> season CA gave the highest percentage since it recorded 8.60 %.

**Table (5): Effect of some foliar spray treatments on sugars and tannins in the fruits of Zaghoul date palm**

Treatments	Reducing sugar %		Non reducing sugars %		Total sugars %		Tannins %	
	1 <sup>st</sup> season	2 <sup>nd</sup> season	1 <sup>st</sup> season	2 <sup>nd</sup> season	1 <sup>st</sup> season	2 <sup>nd</sup> season	1 <sup>st</sup> season	2 <sup>nd</sup> season
T1	56.80 d	57.20 f	8.40 b	8.00 de	65.20 d	65.20 d	0.30 d	0.39 b
T2	57.50 cd	58.00 e	8.20 c	8.30 b	65.70cd	66.30 c	0.49 a	0.52a
T3	59.50 ab	57.00 f	8.60 a	8.20 bc	68.10 a	65.20 d	0.30 d	0.31c
T4	58.00 c	58.40 e	8.40 b	8.20 bc	66.40bc	66.60 c	0.40 c	0.45 b
T5	56.80 d	60.00cd	8.20 c	8.60 a	65.00 d	68.60 a	0.45 b	0.44 b
T6	56.90 d	59.70cd	8.10 cd	7.30 f	65.00 d	67.00bc	0.42 c	0.29 c
T7	57.40 cd	59.60 d	8.10 cd	7.90 e	65.50cd	67.50 b	0.31 d	0.27 c
T8	60.30 a	60.90 a	8.70 a	8.10 cd	69.00 a	69.00 a	0.27 e	0.32 c
T9	60.30 a	60.20bc	8.20 c	8.20 bc	68.50 a	68.40 a	0.30 d	0.30 c
T10	59.00 b	60.70ab	8.00 d	8.00 de	67.00 b	68.70 a	0.31 d	0.29 c

As for total sugars percentage, results in Table (5) show that fruit was affected significantly by different treatments of foliar spray in both seasons. Treated bunches of palm with the mixture of GA<sub>3</sub> + SA gave the

highest fruit content of total sugars percentage ( 69.0 and 69.0 % ) in the 1<sup>st</sup> and 2<sup>nd</sup> seasons without significant differences than GA<sub>3</sub> alone or the mixture of GA<sub>3</sub> + CA in the 1<sup>st</sup> season and with CA alone or the mixture of GA<sub>3</sub> + CA or the mixture of SA+ CA of each in the 2<sup>nd</sup> season. On the other hand, the lowest content of total sugars was obtained by control treatment (65.20 and 65.20) in the 1<sup>st</sup> and 2<sup>nd</sup> seasons.

These results are in harmony with those obtained on date palms since spraying GA<sub>3</sub> at 150 ppm increased total soluble solids percentage and total sugars percentage<sup>34</sup>.

Respecting, tannins content in the fruits, results in Table (5) show that , foliar spray treatments had a significant effect on tannins content in both seasons, since spraying bunches of date palms with NAA significantly increased tannins value in the fruits and recorded the highest values ( 0.49 and 0.52 ) in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. On the other hand, spraying bunches with GA<sub>3</sub>, SA or CA of each in the mixture recorded the lowest value of tannins in the fruits in both seasons.

These results are in harmony with those obtained on date since the foliar application of citric acid at 500 to 2000 ppm significantly decreased total soluble tannins<sup>35</sup>.

It could be concluded that , spraying bunches of date palms with the mixture of GA<sub>3</sub> at 50 ppm + salicylic acid (SA) at 1000 ppm was the best treatment for improving fruit set, fruit retention , bunch weight and fruit quality of date palm under this experiment conditions.

## References

1. FAOSTAT. Food and Agriculture Organization of the United Nation (FAO). <http://www.fao.org>, 2011.
2. El-Kassas SE. The effect of some growth regulators on the yield and fruit quality of Zaghoul date palm. Assuit J. Agric. Res. Sci., 1983, 14(2): 181-191.
3. Hussein MA, El-Ahamy SZ, Amem KIA, Galal S. Physiological studies for prolonging harvest date of Samani dates under Assuit Governorate conditions. Effect of GA<sub>3</sub> and fruit thinning. Assuit J. Agric. Res. Sci., 1992, 23(2):321-334.
4. Kamal HM. Effect of some growth regulators on the physical and chemical properties of date fruits. Bulletin of Fac. Agric. Cairo Univ., 1995, 46 (2): 215-227.
5. Westwood MN. Temperate zone pomology; Physiology and culture, third ed. Timber press, Portland, or, USA, 1993, 523pp.
6. Arteca RN. Plant growth substances: Principles and Applications. In. Davis, P.J. (Ed.), Plant Hormones. Kluwer Academic Publishers, Dordrecht, the Netherlands, 1996, pp.1-15.
7. Davis PJ. The plant hormones: their nature, Occurrence and functions. In. Davis, P.J. (Ed.), Plant Hormones. Kluwer Academic Publishers, Dordrecht, the Netherlands, 2004, pp: 1-15.
8. Agusti M, El-Otmani M, Juan M, Almela V. Effect of 3,5,6 trichloro-2- pyridyloxy acetic acid on Clementine early fruitlet development and fruit size at maturity . J. Hort. Sci., 1995, 70:955-962.
9. Shabana HR, Shereqi RK, Ibrahim M, Al-Safadi W. Effect of naphthalene acetic acid application on the time of ripening and quality of cv. Khaniezy. The first international conference on Date palms. 1998, March 8-10 Al-Ain, United Arab Emirates, 72-77.
10. Al-Juburi HJ, Al-Masry HH, Al-Muhanna SA. Effect of some growth regulators on some fruit characteristics and productivity of Barhee date palm trees cultivar (*Phoenix dactylifera* L.). Fruit. 2001a, 56:325-332.
11. AlJuburi HJ, Al-Masry HH, Al-Banna M, Al-Muhanna SA. Effect of some growth regulators on some fruit characteristics and productivity of date palm trees (*Phoenix dactylifera* L.). 2. Khaniezy cultivar. Proceedings of the Second International Conference on Date Palms, 2001b, March 25-27, Al. Ain, United Arab Emirates. pp.21.
12. AlJuburi HJ, Al-Masry HH. The effects of plant growth regulators application on productivity and fruit characteristics of date palm trees (*Phoenix dactylifera* L.). Proceedings of the International Conference on Date Palms, 2003, September 16-19, Qaseem Branch, King Saud University, Saudi Arabia.393-501.
13. Aboutalebi A, Behroznam B. Study of the effects of plant growth regulators on date fruit characteristics. International Conference on date palm production and processing technology, Book of Abstracts, 9-11 May 2006- Muscat, Oman.
14. Abo El-Komsan, EE, Hegab MY, Fouad AA. Response of Balady orange trees to application of some nutrients and citric. Egypt J. Appl. Sci., 2003, 18(3)228-246.

15. Gabara AA. Growth and fruiting of Washington Navel oranges in relation to foliar application of some antioxidants. *Minia J. Agric. Res. and Develop.*, 2004, 24 (4):580-600.
16. Shaarawy AMA. Response of Balady line trees to organic and biofertilization. *Minia J. Agric. Res. and Develop.*, 2005, 25 (1):1-20.
17. Gamal AF. Response of Washington Naval orange trees to some antioxidants and biofertilization treatments. M.Sc. Thesis Fac. Agric., 2006, Minia Univ. Egypt.
18. Ahmed FF, Mohamed Y, Abdalla BM. The relation between using some antioxidants and productivity of Sewy date palms. *Minia J. Agric. Res. and Develop.*, 2007, 27 (4):753-770.
19. Mahfouz MS. Response of Williams banana to application of ascorbic and some nutrients. M.Sc. Thesis Fac. Agric., 2007, Minia Univ. Egypt.
20. Hamad ASA. Response of the two mango cvs Taimour and Zebda to fertilization and some antioxidants. Ph.D. Thesis Fac. Agric., 2008, Minia Univ. Egypt.
21. Badran MAF, Ahmed FF. The promotive effect of some antioxidants on the productivity of Taimour mango trees. *Minia J. Agric. Res. and Develop.*, 2009, 29 (2):333-348.
22. Roshdy KA, Saad RI, Abdalla BM. Effect of some antioxidants on fruiting of Williams banana. *Egypt. J. Appli. Sci.*, 2011, 26 (3): 118-127.
23. AOAC. Official Methods of Analysis 15<sup>th</sup> ed. Published by A.O.A.C. Washington, 1995, D.C. (U.S.A.).
24. Smith, F., M.A. Gilles, J.K. Hamilton, and P.A. Godess. Colorimetric method for determination of sugars related substances. *Anal. Chem.*, 1956, 28, 350.
25. Schanderl SH. In: *Method in Food Analysis* Academic Press, 1970, New York p 709.
26. Duncan DB. Multiple range and multiple F. testes. *Biometrics*, 1955, 11: 1-24.
27. Tavakkoli A, Tafazoli E, Rahemi M. Effect of ethephon, Naphthalin acetic acid and sevein on fruit characteristics of Shahani date (*Phoenix dactylifer* L.). The fourth Symposium on Date Palm in king Faisal Univ. AlHassa, 2007, Saudi Arabia, 5-8 May, pp: 109.
28. Al-Qurashi AD, Awad MA, Elsayed MI. Pre-harvest fruit drop, bunch weight and fruit quality of 'Rothana' and 'Ghur' date palm cultivars as affected by some plant growth regulators. *African J. Biotechnology*, 2012, 11(81): 14644-14651.
29. Ahmed FF, Abdalla AS, Sabour MT. Growth and fruiting of Williams banana as affected by some antioxidants and biofertilizer treatment. *Minia J. Agric. Res. and Develop.* 2003, 23(1):51-68.
30. Raskin I. Role of salicylic acid in plant. *Ann. Rev. Plant Physiol. Plant Mol. Biol.*, 1992, 43: 439-463.
31. Hussein MA, EL-Agamy SZ, Amin KIA, Galal S. Physiological studies for prolonging harvest dates of Samany dates under Assint Governorate conditions. A- Effect of GA<sub>3</sub> on fruit thinning. 3<sup>rd</sup> Symposium on Date Palm, Date Palm Research Centre, King Faisal Univ., 1993, Saudi Arabia. 1993, 423-433.
32. Abo-El-Ez AT, Behairy ZH, Ahmed AM. Bunch weight and fruit quality "Samani" date palm (*Phoenix dactylifera* L.) as affected by some growth regulators. *J. Agric Sci.*, 2002, Mansoura Univ., 27(1): 517-524.
33. Hesami A, Abdi G. Effect of some plant growth regulates on physiochemical characters of date palm (*Phoenix dactylifera* L.cv. Kabkab) fruit. *Am-Euras. J. Agric. and environ. Sci.*, 2010, 7(3): 277-282.
34. Ahmed MA, Hassan HSA, Soliman SS. Effect of some growth regulators on yield and fruit quality of 'Samani' date palm. *Acta Hort. (ISHI)*, 2010, 882:745-754.
35. Ibrahim HIM, Ahmed FF, Akl AMA, Rizk, MNS. Improving Yield Quantitively and Qualitatively of Zaghoul Date Palms by Using some Antioxidants. *Stem Cell*, 2013, 4(2):34-40.

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