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Physiological studies on Barhee date palm cultivar under *in vitro* and *ex vitro* conditions in the Assiut region of Egypt

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Abstract

The nine antioxidants, and nutrients included boric acid at 0.05%, (Zn, Fe and Mn) at 0.05%, salicylic acid at 0.05%, moringa extract at 0.1%, turmeric extract at 0.1%, garlic extract at 0.1%, potassium silicate at 0.1%, seaweed extract at 0.1%, and glutathione at 0.1% were examined for their impacts on growth, palm nutritional status, yield and fruit quality of Barhee date palm cultivar. The materials were sprayed four times at growth start just after fruit setting and at one-month intervals during 2020 and 2021 seasons. Date palm trees sprayed with antioxidants and nutrients showed the best nutritional status compares to the untreated date palm (control). The treatments enhanced leaf content of pigments N, P, K, Zn, Fe and Mn. Furthermore, it was observed that glutathione, seaweed extract, potassium silicate, garlic extract, turmeric extract, moringa extract, salicylic acid (Zn, Fe and Mn) and boric acid boosted yield and fruit quality of Barhee date palm.

Keywords: antioxidants, glutathione, natural plant extracts, salicylic acid, boric acid, Barhee date palm cultivar.

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1. Introduction

Barhee date palm cultivar is a renowned and unique date palm and is well-liked in both the local and foreign markets. Antioxidants play an important role in plant defense against oxidative stress as well as the biosynthesis of most organic foods and activation of the cell division process. Antioxidant compounds have auxinic action since they have a synergistic effect on growth and productivity of most fruit trees. Their practical application in fruit trees under field conditions is favourably possible. They are very beneficial for preventing free oxygen and reducing cell senescence, as well as protecting the cells from senescence. Moreover, they enhance the cell division and the biosynthesis of organic foods and control the incidence of fungal attack (Galala and Abdou, 1996; Elade, 1992; Raskin, 1992). Recently, using plant extracts, especially garlic, moringa, turmeric, etc, are considered a good alternative for improving date palms production through enhancing fruit quality and marketing. The high content of nutrients in such plant extracts such as vitamins amino acids, plant pigments, antioxidants, phenolic compounds, and volatile oils encourage the need for furthermore studies towards their positive action on fruiting of fruits crops (Srimal, 1997; Viuda-Martos *et al.*, 2007). Spraying nutrients improves fruit set, fruit retention, and development as well as total yield and fruit quality (Sarrwy *et al.*, 2012). The impact of some micro elements, such as boron on dates yield and fruit quality seems to play an important role in achieving satisfactory fruit set and fruit quality (Attalla *et al.*, 2007; Khayyat *et al.*, 2007). Zinc is one of the fundamental elements for plants, it is required for the synthesis of auxins, chlorophylls and starch and metabolism carbohydrate (Marschner, 1995). Boron has many functions in the plant such as hormone transport, salt absorbing, flowering and fruiting process, pollen germination, and direction of pollen tube growth (Abdel Fatah *et al.*, 2008). The target of this study was to elucidate the impact of some antioxidants, and nutrients on fruiting of Barhee date palm cultivar under *in vitro* and *ex vitro* conditions in the Assiut region of Egypt.

2. Materials and methods

2.1 Experimental site and treatments description

The present study was conducted during 2020 and 2021 seasons. Thirty Barhee date palms 11 years old were grown in a private orchard situated west of Qusia city, Assiut governorate, Egypt. The palms are planted at 7.0 × 7.0 meters apart, the palms were produced via tissue culture. The palms are hand pollinated by inserting five strands for each spathe after two days of female cracking and received the common horticultural practices that were already applied in the orchard. Number of bunches was adjusted to ten, and the texture of the soil

was sandy. The study included ten treatments from the control as well as application of antioxidants and nutrients. Each treatment consisted of three replicates, one palm per each. Each palm was sprayed three times at the growth start week of March, just after the fruit set and repeated monthly. Triton B as a wetting agent was added at 0.05% to all solutions. Tables (1-4) show the chemical compositions of used turmeric, garlic, moringa, and seaweed extracts.

Table (1): Chemical composition of turmeric according to Li *et al*. (2011).

Compounds	Values (%)	Compounds	Values
β- bisabalene	1.3	α- pinene (%)	0.1 %
1, 8 - cineol	2.4	Terpinolene (%)	0.3 %
p- cyemen	3.0	Tr- turmerone (%)	31.1 %
p- cymen -8-ol	0.3	Turmerone (%)	10.0 %
Tr- curcumin	6.3	Ascorbic acid (mg)	50.0 mg
Curlone	10.6	ASH (g)	6.8 g
Dehydrocurcumin	2.2	Calcium (g)	0.2 g
Myrecen	0.1	Carbohydrate (g)	69.9 g
α- phellanmdrene	0.1	Fat (g)	8.9 g

Table (2): Chemical composition of garlic oils according to Dhekney (2016).

Compounds	Values (mg/100 g D.W.)	Compounds	Values (mg/100 g D.W.)
Dipropyl disulfide	0.25	Bis- (1- propenyl)- sulfide	0.08
Diallyl disulfide	37.90	Diallyl sulfide	6.59
Dimethyl trisulfide	0.33	Dimethyl disfulide	0.15
Dimethyl thiophene	0.08	Allyl methyl tetrosulfide	1.07
Allyl methyl disulfide	3.69	Allyl propyl trisulfide	0.23
Methyl propyl disulfide	0.25	Diallyl tusuflide	28.06
Methyl 1- propenyl disulfide	0.46	Eugenal	0.23
Allyl pripyl sulfide	0.09		

Table (3): Chemical composition of moringa extract *Moring oleifera* according to Abdou *et al*. (2021).

Constituents	Values	Constituents	Values
a) Vitamins (mg/ 100 g F.W.)		c) Amino acids (mg/ 100 g D.W.)	
Betacarotine	149.2	Lysine	8.3
E	50.0	Leucine	9.3
A	90.0	Threonine	6.6
B1	88.9	Isoleucine	6.3
B2	1.1	Cysteine	2.4
C	19.0	Methionine	3.6
K	25.6	Treptophane	3.3
b) Minerals (mg/ 100 g D.W.)			
Cu	88.7		
K	49.9		
N	89.9		
P	12.9		
Mg	20.2		

Table (4): Analysis of seaweed extract according to James (1994).

Character	Values (%)	Character	Values
Moisture	6.0	Sc	3-9 %
O.M.	45-60	Mg	0.5-0.9 %
Inorganic matter	45-60	Cu	1.0-6.0 ppm
Protein	6-8	Fe	50-200 ppm
Carbohydrates	35-50	Mn	5-12 ppm
Aliginic acid	10-20	Zn	10-100 ppm
Mannitol	4-6	B	20-100 ppm
Total N	1.0-1.5	Mo	1-5 ppm
P	0.02-0.09	Cytokinins	0.02 %
K	1.0-1.2	IAA	0.03 %
Ca	0.2-1.5	ABA	0.01 %

The experiment was arranged in a randomized complete block design (RCBD), Each treatment of the ten treatments was replicated three times, one palm per each replicate. Generally, the following measurements were determined during the two investigated seasons:

1. Leaf morphology characteristics namely, length (cm), width (cm) and area $(cm)^2$ of pinnae, length (m) and area $(m)^2$ of leaf (Ahmed and Morsy, 1999) number of pinnae/leaf, number of spines/ leaf and spine length (cm).
2. Leaf chemical components namely leaf pigments (chlorophyll a, b, total chlorophylls, and total carotenoids (as mg/ g F.W.) (Fadle and Seri- El Deen, 1978; Von-Wettstein, 1957) as well as percentages of N, P, K, Zn, Fe, and Mn on a dry weight basis (Summer, 1985; Wilde *et al.*, 1979).
3. Fruit setting (%), yield/palm (kg), bunch weight (kg), and bunch length (cm).
4. Physical and chemical characteristics of fruits namely fruit weight (g), diameter and height (cm) of fruit, percentages of seed and flesh, TSS (%), total, reducing and non-reducing sugars (A.O.A.C., 2000; Lane and Eynon, 1965), total acidity (as g malic acid/ 100 ml pulp) (A.O.A.C., 2000) and total fibre (%).

Statistical analysis was done according to (Snedecor and Cochran, 1980). New L.S.D. at test at 5% was used to make all comparisons among different treatment means.

3. Results

3.1 Vegetative growth aspects

Data in Tables (5 and 6) clearly show that treating Barhee date palms four times with boric acid at 0.05%, (Zn, Fe and Mn) at 0.05%, salicylic acid at 0.05%, Moringa extract at 0.1%, turmeric extract at 0.1%, garlic extract at 0.1%, potassium silicate at 0.1%, seaweed extract at 0.1% and glutathione at 0.1% significantly stimulated length, width and area of pinnae, length and area of leaf,

number of pinnae/leaf, number of spines/leaf and spine length over the check treatment. The best antioxidant and nutrients in enhancing these aspects were glutathione, seaweed extract, potassium silicate, garlic extract, turmeric extract, moringa extract, salicylic acid, (Zn, Fe and Mn) and boric acid in descending order. Significant differences in these characteristics were observed among the nine antioxidants and nutrients. The maximum values were recorded on the palms treated with glutathione at 0.1%. The lowest values were recorded on untreated palms. A similar trend was noticed during 2020 and 2021 seasons.

Table (5): Effect of spraying some antioxidants and nutrients on some vegetative growth characteristics of Barhee date palms during 2020 and 2021 seasons.

Treatments	Pinnae length (cm)		Pinnae width (cm)		Pinnae area (cm)^2		Number of pinnaes/leaf		Leaf area (m)^2		Leaf length (m)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
T_1 – Control (sprayed with water)	50.5	51.0	2.15	2.22	53.18	54.21	198.0	201.0	1.16	1.18	3.18	3.22
T_2 – Boric acid at 0.05%	52.0	52.4	2.24	2.28	55.11	55.15	203.0	205.0	1.19	1.21	3.32	3.44
T_3 – Zn, Fe and Mn at 0.05%	53.2	54.6	2.35	2.38	56.08	56.40	211.0	216.0	1.22	1.26	3.45	3.50
T_4 – Salicylic acid at 0.05%	54.8	55.0	2.44	2.49	57.00	57.18	215.0	220.0	1.28	1.30	3.54	3.60
T_5 – Moringa extract at 0.1%	55.2	55.5	2.58	2.61	57.88	58.22	222.0	225.0	1.33	1.35	3.58	3.62
T_6 –Turmeric extract at 0.1%	56.8	57.0	2.66	2.69	59.15	59.98	228.0	232.0	1.36	1.38	3.61	3.66
T_7 – Garlic extract at 0.1%	57.0	57.5	2.71	2.73	61.00	61.45	231.0	235.0	1.38	1.41	3.70	3.72
T_8 – Potassium silicate at 0.1%	57.2	58.0	2.76	2.81	62.40	63.00	233.0	236.0	1.42	1.46	3.82	3.90
T_9 – Seaweed extract at 0.1%	59.5	60.0	2.81	2.83	64.00	64.60	235.0	238.0	1.48	1.51	3.92	4.00
T_{10} – Glutathione at 0.1%	60.9	61.5	2.85	2.88	65.66	67.30	237.0	239.0	1.52	1.55	4.10	4.20
New L.S.D. at 5%	0.9	1.1	0.03	0.04	1.03	1.11	2.0	2.4	0.03	0.04	0.08	0.09

3.2 Leaf chemical components

It is evident from the obtained data in Tables (6 and 7) that treating Barhee date palms four times with any one of the nine antioxidants and nutrients (boric acid at 0.05%, Zn, Fe and Mn at 0.05%, salicylic acid at 0.05%, moringa extract at 0.1%, turmeric extract at 0.1%, garlic extract at 0.1%, potassium silicate at 0.1%, seaweed extract at 0.1% and glutathione at 0.1%) was significantly stimulated chlorophylls a, b, total chlorophylls, total carotenoids, N. P. K and Zn, Fe and Mn in the leaves relative to the control treatment. Significant differences on each chemical component were observed among all antioxidants and nutrients. The chemical components highest values of these were observed on the palms that received boric acid, (Zn, Fe and Mn), salicylic acid, moringa extract, turmeric extract, garlic extract, potassium silicate, seaweed extract and glutathione, in ascending order. The highest values of chlorophyll a (6.5, 7.0 mg/ g F.W.), chlorophyll b (4.1, 4.3 mg/ g F.W.), total chlorophylls (10.6. 11.3 mg/ g F.W.), total carotenoids (3.0, 3.2 mg/ g F.W.), N (2.03, 2.05 %), P (0.34, 0.35%), K (1.42, 1.45 %), Zn (74.0, 74.5 ppm), Fe (75.6, 76.0 pm) and Mn (59.5, 60.0 ppm) were recorded on the Barhee date palms that received glutathione at 0.1% during both seasons, respectively. The untreated palms produced the minimum values. Similar trend was noticed during 2020 and 2021 seasons.

Table (6): Effect of spraying some antioxidants and nutrients on number and length of spines and some leaf pigments Barhee date palms during 2020 and 2021 seasons.

Treatments	Number of spines/leaf		Spine length (cm)		Chlorophyll a (mg/ g F. W.)		Chlorophyll b (mg/ g F. W.)		Total chlorophylls (mg/ g F. W.)		Total carotenoids (mg/ g F. W.)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
T_1 – Control (sprayed with water)	18.0	18.5	8.5	8.8	3.4	3.6	1.6	1.5	5.0	5.1	1.2	1.3
T_2 – Boric acid at 0.05%	18.9	19.2	9.2	9.6	3.7	3.9	1.8	1.9	5.5	5.8	1.5	1.6
T_3 – Zn, Fe and Mn at 0.05%	19.5	20.0	9.5	9.8	3.9	4.1	1.9	2.1	5.8	6.2	1.8	1.9
T_4 – Salicylic acid at 0.05%	20.2	20.5	9.9	10.1	4.4	4.5	2.3	2.4	6.7	6.9	1.9	2.0
T_5 – Moringa extract at 0.1%	21.0	21.4	10.3	10.5	4.6	4.8	2.7	2.9	7.3	7.7	2.1	2.3
T_6 –Turmeric extract at 0.1%	21.6	21.9	10.8	11.0	4.9	5.1	2.9	3.1	7.8	8.2	2.3	2.5
T_7 – Garlic extract at 0.1%	22.5	23.0	11.4	11.6	5.3	5.5	3.2	3.4	8.5	8.9	2.5	2.7
T_8 – Potassium silicate at 0.1%	23.4	23.8	11.8	12.0	5.7	5.9	3.5	3.6	9.2	9.5	2.7	2.9
T_9 – Seaweed extract at 0.1%	24.5	25.0	12.0	12.2	6.1	6.4	3.8	3.9	9.9	10.3	2.8	3.0
T_{10} – Glutathione at 0.1%	25.2	26.0	12.4	12.9	6.5	7.0	4.1	4.3	10.6	11.3	3.0	3.2
New L.S.D. at 5%	0.8	0.9	0.3	0.4	0.4	0.5	0.2	0.3	0.7	0.8	0.2	0.2

Table (7): Effect of spraying some antioxidants and nutrients on the percentages of N, P and K (as %) and content of Zn, Fe and Mn (ppm) in the leaves of Barhee date palms during 2020 and 2021 seasons.

Treatments	Leaf N (%)		Leaf P (%)		Leaf K (%)		Leaf Zn (ppm)		Leaf Fe (ppm)		Leaf Mn (ppm)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
T_1 – Control (sprayed with water)	1.65	1.68	0.16	0.17	1.15	1.16	54.2	55.0	56.0	56.0	48.5	49.0
T_2 – Boric acid at 0.05%	1.71	1.73	0.19	0.19	1.18	1.19	55.5	56.0	57.2	57.5	50.0	51.0
T_3 – Zn, Fe and Mn at 0.05%	1.76	1.77	0.21	0.22	1.21	1.23	57.2	58.0	58.4	59.0	51.2	52.3
T_4 – Salicylic acid at 0.05%	1.79	1.81	0.23	0.24	1.23	1.24	59.5	61.2	60.0	61.5	52.5	54.4
T_5 – Moringa extract at 0.1%	1.82	1.84	0.26	0.27	1.25	1.26	62.0	63.5	63.5	64.0	54.0	55.0
T_6 – Turmeric extract at 0.1%	1.86	1.88	0.28	0.29	1.27	1.28	66.4	68.2	68.0	69.0	55.5	56.2
T_7 – Garlic extract at 0.1%	1.91	1.92	0.30	0.31	1.29	1.31	69.4	69.9	70.1	70.5	56.8	57.1
T_8 – Potassium silicate at 0.1%	1.93	1.96	0.32	0.33	1.31	1.33	71.2	72.5	72.0	73.0	57.5	58.0
T_9 – Seaweed extract at 0.1%	1.98	1.99	0.33	0.34	1.38	1.41	73.4	73.7	74.0	75.0	58.2	58.8
T_{10} – Glutathione at 0.1%	2.03	2.05	0.34	0.35	1.42	1.45	74.0	74.5	75.6	76.0	59.5	60.0
New L.S.D. at 5%	0.04	0.05	0.02	0.03	0.03	0.04	3.1	3.3	3.3	3.5	2.8	2.9

3.3 Percentages of initial fruit setting and fruit retention, yield / palm and bunch weight

It is worth to mention from the data in Table (8) that treating Barhee date palms four times with any one the nine materials (Boric acid at 0.05%, (Zn, Fe and Mn) at 0.05, salicylic acid at 0.05 %, moringa extract at 0.1%, turmeric extract at 0.1%, garlic extract at 0.1%. potassium silicate at 0.1%, seaweed extract at 0.1% and glutathione at 0.1% significantly was accompanied with improving percentages of initial fruit setting and fruit retention, yield / palm, bunch weight and bunch length, over the control treatment. The best antioxidants were glutathione and seaweed extract followed be antioxidants of potassium silicate and garlic extract. Significant differences on these parameters were observed among the nine antioxidants and nutrients. The best treatment was the application of glutathione at 0.1% untreated palms produced the lowest values during both seasons.

Table (8): Effect of spraying some antioxidants and nutrients on number of strands/ spathe, percentage of initial fruit setting and retention , bunch weight and length and yield/palm of Barhee date palms during 2020 and 2021 seasons.

Treatments	Number of strands/spathe		Initial fruit setting (%)		Fruit retention (%)		Bunch weight (kg)		Bunch length (cm)		Yield/palm (kg)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
T_1– Control (sprayed with water)	81.0	78.0	51.5	52.5	42.0	43.0	14.5	14.6	125.5	127.0	145.0	146.0
T_2 – Boric acid at 0.05%	83.0	85.0	53.1	53.8	43.5	44.0	15.2	15.4	128.0	129.0	152.0	154.0
T_3 – Zn, Fe and Mn at 0.05%	84.5	85.8	54.0	54.7	44.2	44.8	15.9	16.2	129.4	131.0	159.0	162.0
T_4 – Salicylic acid at 0.05%	87.0	87.5	55.2	56.0	45.0	45.6	16.3	16.7	133.0	134.5	163.0	167.0
T_5 – Moringa extract at 0.1%	88.8	89.2	57.0	57.5	45.8	46.2	16.9	17.1	136.0	137.0	169.0	171.0
T_6 – Turmeric extract at 0.1%	89.5	90.4	58.2	59.0	46.7	47.4	17.3	17.6	138.2	139.0	173.0	176.0
T_7 – Garlic extract at 0.1%	91.0	91.6	59.4	60.0	47.5	48.2	18.1	18.5	141.0	143.0	181.0	185.0
T_8 – Potassium silicate at 0.1%	92.2	93.0	61.0	61.8	49.0	49.5	18.9	19.4	145.0	146.5	189.0	194.0
T_9 – Seaweed extract at 0.1%	93.0	94.0	62.4	63.0	50.1	50.9	19.4	19.9	149.0	151.0	194.0	199.0
T_{10} – Glutathione at 0.1%	95.0	96.0	63.5	64.5	51.2	52.0	20.2	21.4	153.0	156.0	202.0	214.0
New L.S.D. at 5%	1.3	1.4	1.6	1.7	1.2	1.3	1.7	1.8	1.9	2.1	6.3	7.2

3.4 Some physical and chemical characteristics of the fruits

It is noticed from the data in Tables (9 and 10) that treating the palms four times with any antioxidant and nutrients namely (Boric acid at 0.05%, (Zn, Fe and Mn) at 0.05%, salicylic acid at 0.05 %, moringa extract at 0.1%, turmeric extract at 0.1%, garlic extract at 0.1%. potassium silicate at 0.1%, seaweed extract at 0.1% and glutathione at 0.1% was significantly very effective in improving quality of the fruits in terms of increasing seed weight, diameter and length of fruit, flesh weight %, TSS %, total reducing and non-reducing sugars % and increasing seed weight %, total acidity % and total crude fibre % over the check treatments. The best antioxidants and nutrients in this respect in descending order were glutathione, seaweed extract, potassium silicate, garlic extract, turmeric extract, moringa extract, salicylic acid, (Zn, Fe and Mn) and boric acid. The best results were obtained due to treating the palms four times with glutathione at 0.1%. Similar results were obtained during 2020 and 2021 seasons.

Table (9): Effect of spraying some antioxidants and nutrients on some physical characteristics of the fruits of Barhee date palms during 2020 and 2021 seasons.

Treatments	Fruit weight (g)		Fruit length (cm)		Fruit diameter (m)		Seed weight (g)		Flesh (%)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
T_1– Control (sprayed with water)	12.5	12.8	2.9	3.1	2.1	2.2	10.33	10.22	89.67	89.78
T_2 – Boric acid at 0.05%	13.2	13.5	3.0	3.2	2.2	2.3	10.00	9.98	90.0	90.02
T_3 – Zn, Fe and Mn at 0.05%	13.7	14.0	3.1	3.3	2.3	2.4	9.95	9.88	90.05	90.12
T_4 – Salicylic acid at 0.05%	14.4	14.5	3.3	3.4	2.4	2.5	9.80	9.72	90.20	90.28
T_5 – Moringa extract at 0.1%	14.8	14.9	3.4	3.5	2.5	2.6	9.70	9.60	90.30	90.40
T_6 – Turmeric extract at 0.1%	15.2	15.6	3.6	3.7	2.6	2.7	9.55	9.40	90.45	90.60
T_7 – Garlic extract at 0.1%	15.9	16.2	3.7	3.8	2.7	2.8	9.35	9.25	90.65	90.75
T_8 – Potassium silicate at 0.1%	16.3	16.8	3.9	4.0	2.9	3.0	9.10	9.00	90.90	91.00
T_9 – Seaweed extract at 0.1%	16.9	17.2	4.1	4.2	3.0	3.1	8.80	8.70	91.20	91.30
T_{10} – Glutathione at 0.1%	17.3	17.6	4.3	4.3	3.2	3.3	8.60	8.50	91.40	91.50
New L.S.D. at 5%	0.4	0.5	0.1	0.2	0.1	0.1	0.05	0.06	0.17	0.18

Table (10): Effect of spraying some antioxidants and nutrients on some chemical characteristics of the fruits of Barhee date palms during 2020 and 2021 seasons.

Treatments	TSS (%)		Total sugars (%)		Reducing sugars (%)		Non- reducing sugars (%)		Titratable acidity (%)		Total fibre crude (%)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
T_1– Control (sprayed with water)	31.0	31.5	26.1	26.8	19.0	19.5	7.1	7.3	0.265	0.260	1.85	1.80
T_2 – Boric acid at 0.05%	32.8	33.0	27.8	28.1	20.0	20.3	7.8	7.8	0.252	0.248	1.72	1.71
T_3 – Zn, Fe and Mn at 0.05%	33.5	33.8	28.6	28.9	20.9	20.5	7.8	8.4	0.240	0.230	1.68	1.62
T_4 – Salicylic acid at 0.05%	34.2	34.7	29.3	29.6	21.2	21.4	8.1	8.2	0.225	0.205	1.51	1.45
T_5 – Moringa extract at 0.1%	34.8	35.2	29.9	30.3	21.6	21.9	8.3	8.4	0.205	0.190	1.42	1.35
T_6 – Turmeric extract at 0.1%	35.6	36.1	30.7	31.2	22.0	22.2	8.7	9.0	0.190	0.177	1.28	1.25
T_7 – Garlic extract at 0.1%	36.2	36.9	31.4	32.0	22.5	22.5	8.9	9.5	0.175	0.168	1.11	1.05
T_8 – Potassium silicate at 0.1%	37.0	38.5	32.0	33.3	23.	23.3	9.0	10.0	0.165	0.155	0.99	0.92
T_9 – Seaweed extract at 0.1%	37.9	39.0	33.0	34.0	23.5	23.8	9.5	10.2	0.155	0.145	0.91	0.85
T_{10} – Glutathione at 0.1%	39.0	40.0	34.0	34.9	23.8	24.2	10.2	10.7	0.145	0.140	0.82	0.75
New L.S.D. at 5%	0.8	0.9	0.7	0.8	0.6	0.7	0.4	0.5	0.038	0.042	0.22	0.24

4. Discussion

4.1 Effect of some nutrients

Nutrients play many important regulatory roles in activating various enzymes, biosynthesis of organic foods, plant pigments, hormones, vitamins and enhancing cell division as well as water and nutrient uptake (Mengel *et al.*, 2001; Yagodin, 1990). Foliar fertilization has the advantage of low application rates, uniform distribution of fertilizer materials and quick responses to applied nutrients (Umer *et al.*, 1999). These results are nearly in the same line with these obtained by Moghimi (2007), El-Salhy *et al.* (2007), Desouky *et al.* (2007), Harhas and Abdel-Nasser (2010), Sayed-Ola (2014), and Khodair (2015).

4.2 Effect of spraying seaweed extract

The promoting effect of seaweed extract on growth nutritional status of the palms, yield as well as physical and chemical characteristics of the fruits might be attributed to its higher own from natural hormones namely IAA, GA_3 and cytokinins that are responsible for promoting growth. It is also contain, glutathione, lecithin, adenylic acid, co-enzymes, vitamins, glucine, it is very essential for the synthesis of protoporphyrin, the precursor of plant pigments and the promoter of photosynthesis through enhancing the release of CO_2. Also, it plays an important role in increasing the resistance of trees for all stresses (Dammas, 1998; Lugtenderg *et al.*, 1991). The results are in agreement with those obtained by Abd-Eimotty and Fawzy (2005), Mouftah (2007), and El-Sayed- Esraa (2010).

4.3 Effect of spraying salicylic acid

The positive action of salicylic acid on fruiting of Barhee date palms might be attributed to its essential role on enhancing cell division as well as the biosynthesis of sugars, plant pigments and the tolerance of plants to all stresses (Hayat and Ahmed, 2007; Joseph *et al.*, 2010). The results are in agreement with those obtained by Ragab (2004), Eshmawy (2015), and Ahmed *et al.* (2013).

4.4 Effect of spraying antioxidants

The positive action of antioxidants on growth, palm nutritional status, yield and fruit quality might be attributed to their higher content of proteins, amino acids, nutrients, vitamins, pigments, phenolic compounds and volatile oils (Martos *et al.*, 2007; Srimal, 1997). These results are in harmony with those obtained by Mohamed and Mohamed, (2013), Al-Wasfy *et al.* (2013), and Ahmed *et al.* (2015).

5. Conclusion

As outstanding promotion on yield and fruit quality of Barhee date palms grown under sandy soil was observed due to spraying the palms four times (1st week of March, April, May and June) with glutathione at 0.1%.

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