Available online free at www.futurejournals.org

The Future Journal of Horticulture

Print ISSN: 2692-5826 Online ISSN: 2692-5834

Future Science Association

Future J. Hort., 3 (2020) **8-15** **OPEN ACCES**

DOI: 10.37229/fsa.fjh.2020.09.17

EFFECT OF GIBBERELLIN, BENZYLADENINE AND ASCORBIC ACID ON FLOWERING, FRUIT SET AND YIELD OF COSTATA PERSIMMON TREES

Darwesh, D. R.

Deciduous Fruit Res. Dept., Hortic. Res. Inst., Agriculture Research Center, Giza, **Egypt**.

***Corresponding author:** darwesh.abeed@gmail.com **Received:** 10 Aug. 2020 **; Accepted:** 17 Sept. 2020

ABSTRACT: This investigation was conducted during 2017 and 2018 seasons on twenty years old persimmon trees (*Diospyros kaki L.*) Costata cultivar budded on Tarabuls rootstock (*Diospyros virgeniana*) grown in loamy soil under flood irrigation system at El-kanater Horticultural Research Station, Egypt. The study aimed to enhance flowering, yield and fruit quality particularly fruit size using foliar applications with growth regulators substances namely, gibberellic acid, benzyladenine, and ascorbic acid. The obtained data showed that, all treatments had significant effects on all experimental parameters. The most effective treatment was benzyladenine foliar application with a concentration of 40 ppm that gained 31.66 and 35.27 kg fruit per tree compared to the control, which gained 13.65 and 13.32 kg fruit per tree in the first and second seasons, respectively.

Key words: Persimmon trees, Costata,, Fruit set, Gibberellic acid, Benzyladenine and Ascorbic acid.

INTRODUCTION

Japanese persimmon (*Diospyros kaki L.*) is a deciduous fruit tree grown under the Egyptian environmental conditions since 1911 and successfully grown due to its low chilling requirements. Costata cultivar is the main persimmon variety progressively consumed in the Egyptian market and exportation according to **Fathi *et al.*, 2011**. The cultivated area increased especially in the last few years. It reached 2197 feddans and the total annual production reached nearly 17466 tons of fruits according to the **Ministry of Agriculture and Land Reclamation, 2017**. In many Egyptian orchards, the June drop and pre-harvest drop problem exists extensively because the Costata persimmon is a parthenocarpic cultivar **El-Shaikh *et al.*, 1999**. According to **Abd El-Ghany, 2005** the factors may cause persimmon fruit drop before June (initial drop) due to the competition among the fruits on the nutrients, water and the defect in hormonal balance.

Plant growth regulators play an important role in the growth and fruiting of many fruit crops since they encourage fruit set and reduce fruit drop in many fruit trees species and varieties according to **Saleem *et al.*, 2008; Guirguis, *et al.*, 2010 and Mahmoud, 2012.**

Gibberellin is a plant hormone that, controls developmental processes such as germination, shoot elongation, tuber formation, flowering, fruit set, and growth in diverse species according to **Serrani *et al.*, 2007 and Abdel-Mohsen and Kamel, 2015.**

The most widely distributed cytokinins are the synthetic benzyladenine and kinetin. Benzyladenine can hasten cell division, promote carbohydrate metabolism and create new source-sink relationships hence leading to increased sink strength and fruit size at harvest according to **Moatshe *et al.*, 2011 and Abdel-Mohsen and Kamel, 2015.**

Ascorbic acid is a vitamin known as a growth-regulating factor that influences many biological processes. It is currently considered to as plant growth regulator due to its effect on cell division, increasing nucleic acid content , carbohydrates, proteins metabolism, photosynthesis, and respiration as well as the presence of excess ascorbic acid, the indole-acetic acid oxidation catalysis is apparently blocked according to **Price, 1966; Palmieri and Giovinazzi, 2006 and Mahmoud, 2016.**

The aims of this study are improving flowering, yield and fruit quality particularly fruit size of

persimmon trees by using foliar applications with growth regulators substances as gibberellic acid, benzyladenine and ascorbic acid.

MATERIALS AND METHODS

The present investigation was carried out in El-kanater Horticultural Research Station, Egypt during the 2017 and 2018 seasons on twenty years old persimmon trees Costata cultivar (*Diospyros kaki L.*) to improve yield and fruit quality. The trees were budded on Tarabuls rootstock (*Diospyros virgeniana*) with spacing 5×5 m, grown in loamy soil under flood irrigation system. Twenty-four uniform fruiting and healthy trees, randomly selected to study the effect of some growth regulators concentration of gibberellic acid (GA_3) at 20 ppm and 40 ppm, benzyladenine (BA) at 20 ppm and 40 ppm and ascorbic acid (VC) at 100 ppm and 150 ppm, comparing to tap water sprayed (control). The foliar applications were applied two times in two physiological stages. The first application was at the full bloom, where the second application was at a fruitlet diameter of 0.5-1.0 cm.

The treatments were arranged in a completely randomized design and each treatment has three replicate and each replicate was represented by two trees. The data obtained were statistically analyzed using the analysis of variance method as reported by **Snedecor and Cochran, 1980.** The differences between means were differentiated by using **Duncan's range test (Duncan, 1958).** The studded treatments evaluated throw the following parameters:

1- Vegetative growth characteristics

Four main branches labeled for each excremental tree in the four directions. The number of leaves per shoot, number of shoots per branch, leaf dry weight (g) were determined and measured as well as leaf surface area (cm^2) was determined using discs of the leaf blades according to **Bremner and Taha, 1966.**

2- Leaf chemical composition

The dried leaves were finely grinded and digested using microckeildahl unit. The percentage of nitrogen content was determined according to **Naguib, 1969.** Phosphorus percentage was determined according to **A.O.A.C., 1990.** Potassium percentage was determined according to **Brown and Lilliland, 1964.**

3- The fruiting, yield parameters and yield

- Fruit set and yield: Percentage of initial fruit set (15 days after full bloom) was calculated as a number of fruits per 100 flowers on four main branches for all treatments and control according to **Westwood, 1993.**
- Yield, the weight of fruits which harvested at maturity for each tree was recorded as Kg/tree.
- Total fruit drop: percentage of fruit drop was calculated by the following equation:

$$\text{Fruit drop (\%)} = \frac{\text{Number of fruitlets at fruit set} - \text{Number of harvested fruits}}{\text{Number of fruitlets at fruit set}} \times 100$$

4- Fruit physical characteristics

Samples of fruits were collected from each treatment (30 fruits/tree) for the determination of fruit characteristics at the same time (Picking dates in the first week of October in both seasons) according to **Ben–Arice and Guelfat- Reich, 1973** to determine physical and chemical characters. Fruit weight (g), fruit size (cm^3) and fruit dimensions (cm) were determined and measured as well as Fruit firmness was measured with Effegl, Pentrometer 11.1 mm diameter prop, Effigl, Alfonsing, Italy and expressed as $Lb/inch^2$.

5- Fruit chemical characteristics

TSS percentage in fruit juice values measured by the handy refractometer according to **A.O.A.C., 1990.** Juice acidity (%) was determined according to **A.O.A.C., 1990** and calculated as gram anhydrous Malic acid /100ml juice. Total tannin content according to **A.O.A.C., 1990.**

RESULTS

Vegetative growth characteristics

Data in Table (1) showed the effect of gibberellic acid (GA), benzyladenine (BA) and ascorbic acid (VC) with different concentrations on vegetative growth characteristics of persimmon trees "Costata" cultivar through 2017 and 2018 seasons. The differences between growth regulators types and their concentrations for vegetative growth characteristics were significant and have the same trend in both seasons. All the tested treatments have significant effects on all the experimental parameters compared to the control but BA effect was better than GA or VC and it has the greatest values in both seasons.

Regarding numbers of leaves per shoot, the highest values were 19.98 and 25.39 for benzyladenine 40 ppm (BA) compared to the control that produced 15.27 and 15.79 in the 1st and 2nd seasons, respectively. Also, leaf area, numbers of shoots per branch and leaf dry weight have the same trend for all growth regulators substances in both seasons. For example, the highest values for leaf area were 46.77 and 45.72 cm^2 that produced by BA 20 and 40 ppm compared to the control (35.40 cm^2) in the 1st season but in the second season, the highest value was 48.72 cm^2 that produced by BA 40 ppm compared to the control (40.60 cm^2).

Table 1. Effect of foliar application with gibberellic acid, benzyladenine and ascorbic acid with different concentrations on some vegetative growth characteristics of persimmon trees (2017-2018 seasons)

Parameters / Treatments	No. of leaves per shoot		Leaf surface area (cm)²		No. of shoots per branch		Leaf dry weight (g)	
	Values	±%	Values	±%	Values	±%	Values	±%
First season								
Control	15.27 d	-	35.40 e	-	11.30 d	-	0.43 e	-
GA 20 ppm	17.92 bc	17.35	42.07 c	18.84	14.70 b	30.09	0.52 c	20.93
GA 40 ppm	18.66 b	22.20	44.18 b	24.80	15.40 b	36.28	0.57 b	32.56
BA 20 ppm	18.76 b	22.86	45.72 a	29.15	18.49 a	63.63	0.66 a	53.49
BA 40 ppm	19.98 a	30.84	46.77 a	32.12	18.51 a	63.81	0.65 a	51.16
VC 100 ppm	15.67 d	2.62	36.75 e	3.81	12.14 c	7.43	0.47 d	9.30
VC 150 ppm	16.57 cd	8.51	38.45 d	8.62	12.66 c	12.04	0.47 d	9.30
Second season								
Control	15.79 d	-	40.60 e	-	13.57 d	-	0.44 d	-
GA 20 ppm	20.32 b	28.69	44.60 c	9.85	15.69 c	15.62	0.54 bc	22.73
GA 40 ppm	21.41 b	35.59	46.89 b	15.49	16.42 c	21.00	0.58 b	31.82
BA 20 ppm	24.47 ab	54.97	47.24 b	16.35	17.41 b	28.30	0.66 a	50.00
BA 40 ppm	25.39 a	60.80	48.72 a	20.00	19.26 a	41.93	0.67 a	52.27
VC 100 ppm	16.33 d	3.42	41.82 de	3.00	14.33 d	5.60	0.47 d	6.82
VC 150 ppm	18.45 c	16.85	43.14 cd	6.26	14.36 d	5.82	0.48 cd	9.09

Control = tap water, GA= Gibberellic acid, BA= Benzyladenine and VC= Ascorbic acid.
*±% = increase or decrease % in relation to control.
Means followed by the same letter\s within each column are not significantly different from each other at 0.5% level.

Leaf chemical composition

Table (2) revealed the effect of gibberellic acid, benzyladenine and ascorbic acid with different concentrations on leaf chemical composition of persimmon trees Costata cultivar through 2017 and 2018 seasons. The differences between growth regulators types and their concentrations for leaf chemical composition were significant and have the same trend in both seasons. All the tested treatments have significant effects on all the experimental parameters compared to the control but BA effect was greater than GA or VC and it has the greatest values in both seasons.

For nitrogen percentage, BA 20 and 40 ppm gained the highest values that were 2.493 and 2.450%, respectively compared to the control that produced 1.923% in the 1st season but in the 2nd season, the highest value was 2.527 that gained from BA 40 ppm compared to the control that was 1.877 %. Moreover, Phosphorus and Potassium have the same trend for all growth regulators substances in both seasons. For potassium, the highest values were 1.733 and 1.753 %, which get by BA 40 ppm compared to 1.334 and 1.267% that get by the control in the first and the second, respectively.

The fruiting, yield parameters and yield

Present data in Table (3) reported the effect of gibberellic acid, benzyladenine and ascorbic acid with different concentrations on fruiting, yield parameters and yield of persimmon trees Costata cultivar through 2017 and 2018 seasons. The differences between growth regulators types and their concentrations for fruiting, yield parameters and yield were significant in both seasons. All the tested treatments have significant effects on all the experimental parameters compared to the control but BA effect was better than GA or VC and it has the greatest values in both seasons.

For fruit set percentage, the highest values were gained by BA 40 ppm that were 52.64 and 49.13 % compared to the control that were 41.33 and 39.74 % in the first and the second seasons, respectively. In addition, fruit weight, numbers of fruit per tree and tree yield have the same trend to fruit set percentage for all growth regulators substances in both seasons. For example, BA 40 ppm produced the highest tree yield that were 31.66 and 35.27 kg per tree compared to the control that were 13.65 and 23.32 kg per tree. Regarding, the fruit drop percentage has an oboist trend to fruit set percentage in both seasons.

Table 2. Effect of foliar application with gibberellic acid, benzyladenine and ascorbic acid with different concentrations on nitrogen, phosphorus and potassium leaf content of persimmon trees (2017-2018 seasons)

Parameters / Treatments	Nitrogen (%)		Phosphorus (%)		Potassium (%)	
	Values	±%	Values	±%	Values	±%
			First season			
Control	1.923 e	-	0.225 d	-	1.334 f	-
GA 20 ppm	2.257 bc	0.33	0.243 d	0.02	1.527 d	0.19
GA 40 ppm	2.287 b	0.36	0.277 c	0.05	1.577 c	0.24
BA 20 ppm	2.493 a	0.57	0.335 b	0.11	1.660 b	0.33
BA 40 ppm	2.450 a	0.53	0.338 a	0.11	1.733 a	0.40
VC 100 ppm	2.093 d	0.17	0.225 d	0.00	1.440 ef	0.11
VC 150 ppm	2.128 cd	0.21	0.235 d	0.01	1.410 e	0.08
			Second season			
Control	1.877 e	-	0.223 d	-	1.267 f	-
GA 20 ppm	2.215 c	0.34	0.240 d	0.02	1.527 d	0.26
GA 40 ppm	2.270 bc	0.39	0.285 c	0.06	1.590 c	0.32
BA 20 ppm	2.385 b	0.51	0.332 b	0.11	1.700 b	0.43
BA 40 ppm	2.527 a	0.65	0.386 a	0.16	1.753 a	0.49
VC 100 ppm	1.910 e	0.03	0.228 d	0.01	1.320 f	0.05
VC 150 ppm	2.084 d	0.21	0.237 d	0.01	1.477 e	0.21

Control = tap water, GA= Gibberellic acid, BA= Benzyladenine and VC= Ascorbic acid.
*±% = increase or decrease % in relation to control.
Means followed by the same letter\s within each column are not significantly different from each other at 0.5% level.

Table 3. Effect of foliar application with gibberellic acid, benzyladenine and ascorbic acid with different concentrations on fruiting, yield parameters and yield of persimmon trees (2017-2018 seasons)

Parameters / Treatments	Fruit set (%)		Fruit drop (%)		Fruit weight (g)		No. of fruit per tree		Yield (kg/tree)	
	Values	±%	Values	±%	Values	±%	Values	±%	Values	±%
					First season					
Control	41.33 e	-	55.71 a	-	81.33 g	-	166.33 f	-	13.65 f	-
GA 20 ppm	47.14 c	5.81	38.95 d	16.76-	95.00 d	16.81	198.33 d	19.24	18.84 d	38.02
GA 40 ppm	47.50 bc	6.17	37.45 d	18.26-	98.00 c	20.50	230.00 c	38.28	22.53 c	65.05
BA 20 ppm	49.20 b	7.87	29.54 e	26.17-	102.33 b	25.82	257.87 b	55.04	26.40 b	93.41
BA 40 ppm	52.64 a	11.31	28.46 e	27.25-	109.00 a	34.02	290.47 a	74.63	31.66 a	131.94
VC 100 ppm	44.97 dc	3.64	44.59 b	11.12-	86.33 f	6.15	177.33 e	6.61	15.63 e	14.51
VC 150 ppm	45.83 d	4.50	41.82 c	13.89-	90.33 e	11.07	187.67de	12.83	16.95 e	24.18
					Second season					
Control	39.74 f	-	52.13 a	-	85.00 f	-	156.70 g	-	13.32 g	-
GA 20 ppm	45.83 cd	6.09	39.93 d	10.66-	96.20 c	13.18	227.83 d	45.39	21.92 d	64.56
GA 40 ppm	46.77 bc	7.03	36.18 e	15.27-	97.19 c	14.34	245.43 c	56.62	23.85 c	79.05
BA 20 ppm	47.76 ab	8.02	31.57 f	16.44-	100.60 b	18.35	289.17 b	84.54	29.09 b	118.39
BA 40 ppm	49.13 a	9.39	30.40 f	18.38-	110.00 a	29.41	320.67 a	104.64	35.27 a	164.79
VC 100 ppm	42.37 e	2.63	46.84 b	4.00-	88.33 e	3.92	187.63 f	19.74	16.57 f	24.40
VC 150 ppm	44.57 d	4.83	42.84 c	6.91-	92.17 d	8.44	199.73 e	27.46	18.42 e	38.29

Control = tap water, GA= Gibberellic acid, BA= Benzyladenine and VC= Ascorbic acid.
*±% = increase or decrease % in relation to control.
Means followed by the same letter\s within each column are not significantly different from each other at 0.5% level.

Fruit physical characteristics

Table (4) cleared the effect of ascorbic acid, gibberellic acid, benzyladenine and ascorbic acid with different concentrations on fruit physical characteristics of persimmon trees Costata cultivar through 2017 and 2018 seasons. The differences between growth regulators types and its concentrations for fruit physical characteristics were significant except the fruit shape index was insignificant in both seasons. All the tested treatments have significant effects on all the experimental parameters compared to the control but BA effect was better than GA or VC and it has the greatest values in both seasons.

The highest values for fruit weight were gained by BA 20 and 40 ppm that were 120.70 and 122.00 g, respectively compared to the control that was 94.00 g in the first season. In the second, the highest value for fruit weight gained by BA 40 ppm that was124.00 g compared to the control that was 104.30 g. In addition, fruit length, fruit diameter, and fruit firmness have the same trend to fruit weight for all growth regulators substances in both seasons. For example, BA 40 ppm produced the highest fruit firmness that were 24.35 and 25.16 Ib/inch^2 compared to the control that were 22.83 and 23.24 Ib/inch^2 in the first and the second seasons, respectively.

Table 4. Effect of foliar application with gibberellic acid, benzyladenine and ascorbic acid with different concentrations on fruit physical characteristics of persimmon trees (2017-2018 seasons)

Parameters / Treatments	Fruit size (cm^3)		Fruit length (cm)		Fruit diameter (cm)		Fruit shape index (L/D)		Fruit firmness (Ib/inch2)	
	Values	±%	Values	±%	Values	±%	Values	±%	Values	±%
First season										
Control	94.0 e	-	5.23 c	-	5.37 d		0.973 a	-	22.83 e	-
GA 20 ppm	115.3 b	22.66	5.90 b	12.81	6.10 b	13.59	0.968 a	-	24.22 bc	6.09
GA 40 ppm	119.7 ab	27.34	6.19 ab	18.36	6.32 ab	17.69	0.979 a	-	24.50 bc	7.31
BA 20 ppm	120.7 a	28.40	6.30 a	20.46	6.30 ab	17.32	1.002 a	-	24.77 ab	8.50
BA 40 ppm	122.0 a	29.79	6.31 a	20.65	6.39 a	18.99	0.987 a	-	25.35 a	11.04
VC 100 ppm	99.3 d	5.64	5.35 c	2.29	5.31 d	1.12-	1.008 a	-	23.65 d	3.59
VC 150 ppm	108.0 c	14.89	5.48 c	4.78	5.65 c	5.21	0.970 a	-	23.89 cd	4.64
Second season										
Control	104.3 g	-	5.33 d	-	5.21 d	-	1.022 a	-	23.24 e	-
GA 20 ppm	111.7 d	7.09	6.13 b	15.01	5.87 c	12.67	1.045 a	-	24.38 c	4.91
GA 40 ppm	118.0 c	13.14	6.41 ab	20.26	6.24 b	19.77	1.028 a	-	24.60 bc	5.85
BA 20 ppm	120.7 b	15.72	6.42 ab	20.45	6.18 ab	18.62	1.039 a	-	24.91 ab	7.19
BA 40 ppm	124.0 a	18.89	6.48 a	21.58	6.41 a	23.03	1.011 a	-	25.16 a	8.26
VC 100 ppm	107.0 f	2.59	5.42 d	1.69	5.18 d	0.58-	1.046 a	-	23.40 de	0.69
VC 150 ppm	109.3 e	4.79	5.74 c	7.69	5.25 d	0.77	1.094 a	-	23.66 d	1.81

Control = tap water, GA= Gibberellic acid, BA= Benzyladenine and VC= Ascorbic acid.
*±% = increase or decrease % in relation to control.
Means followed by the same letter\s within each column are not significantly different from each other at 0.5% level.

Fruit chemical characteristics

Results in Table (5) summarize the effect of ascorbic acid, gibberellic acid, benzyladenine and ascorbic acid with different concentrations on fruit chemical characteristics of persimmon trees Costata cultivar through 2017 and 2018 seasons. The differences between growth regulators types and its concentrations for fruit chemical characteristics were significant in both seasons. All the tested treatments have significant effects on all the experimental parameters compared to the control but BA effect was better than GA or VC and it has the greatest values in both seasons.

The highest values for TSS% were gained by BA 20 and 40 ppm that were 24.79 and 25.00 %, respectively compared to the control that was 22.25 % in the first season. In the second, the treatments have the same trend compared to the control for all growth regulators substances in both seasons. In addition, acidity, TSS/ acid ratio and firmness were having the same trend to TSS in both seasons.

Table 5. Effect of foliar application with gibberellic acid, benzyladenine and ascorbic acid with different concentrations on some fruit chemical characteristics of persimmon trees (2017-2018 seasons)

Parameters / Treatments	TSS (%)		Acidity (%)		T.S.S/Acid (ratio)		Tannins (%)	
	Values	±%	Values	±%	Values	±%	Values	±%
First season								
Control	22.25 f	-	0.637 e	-	34.953 f	-	0.384 d	-
GA 20 ppm	24.25 c	2.00	0.558 c	0.08-	43.471 c	24.37	0.529 c	0.15
GA 40 ppm	24.47 bc	2.22	0.542 b	0.10-	45.154 b	29.18	0.589 c	0.21
BA 20 ppm	24.79 ab	2.54	0.520 b	0.12-	47.640 a	36.30	0.684 b	0.30
BA 40 ppm	25.00 a	2.75	0.516 a	0.12-	48.447 a	38.61	0.859 a	0.48
VC 100 ppm	23.05 e	0.80	0.623 e	0.01-	36.999 e	5.85	0.397 d	0.01
VC 150 ppm	23.45 d	1.20	0.614 d	0.02-	38.193 d	9.27	0.453 d	0.07
Second season								
Control	22.35 c	-	0.632 d	-	35.383 e	-	0.406 d	-
GA 20 ppm	23.47 b	1.12	0.574 b	0.06-	40.891 c	15.57	0.536 c	0.13
GA 40 ppm	23.55 b	1.20	0.559 a	0.07-	42.113 c	19.02	0.635 b	0.23
BA 20 ppm	24.53 a	2.18	0.541 a	0.09-	45.327 b	28.10	0.657 b	0.25
BA 40 ppm	24.71 a	2.36	0.526 a	0.11-	46.998 a	32.83	0.780 a	0.37
VC 100 ppm	22.52 c	0.17	0.627 c	0.01-	35.912 d	1.5	0.442 d	0.04
VC 150 ppm	22.66 c	0.31	0.615 b	0.02-	36.868 d	4.2	0.461 d	0.06

Control = tap water, GA= Gibberellic acid, BA= Benzyladenine and VC= Ascorbic acid.
*±% = increase or decrease % in relation to control.
Means followed by the same letter\s within each column are not significantly different from each other at 0.5% level.

DISCUSSION

Foliar applications with growth regulators substances i.e. gibberellic acid, benzyladenine, and ascorbic acid had great effect on improving flowering, yield and fruit quality particularly fruit size of persimmon trees. Data of this study indicated that the sprayed with BA, GA and VC gave significantly increased in all vegetative growth characteristics compared with the control trees in both seasons. The previous results were in agreement with **George *et al.*, 2008; Moatshe *et al.*, 2011 and Ashour *et al.*, 2018** who cleared that the application of BA improved cell division, enhancing cell enlargement, promote carbohydrate metabolism, development of plastids and delaying the breakdown of chlorophyll, proteins, and RNA as well as plant growth. Moreover, GA improving vegetative growth (**Shinde *et al.*, 2008; Panigrahi and Strivastava, 2011 and Mahmoud, 2012)**. The improving effect of VC on growth might be attributed to its auxinic action that was reflected on simulating the biosynthesis of carbohydrates, plant pigments, building of amino acids especially RNA, enhancing cell division and cell enlargement which reflected positively on leaf area (**Mazher, 2011**; **El-Badawy, 2013; El-Badawy *et al.*,2017 and Mahmoud, 2016)**.

With regard to the increasing of leaf chemical composition during the spraying with BA, GA and

VC may be due to improving vegetative growth functions by BA application (**George *et al.*, 2008; Moatshe *et al.*, 2011 and Ashour *et al.*, 2018).** additionally**,** the beneficial effects of ascorbic acid on growth characteristics and uptake of water and different nutrients according to (**Rao *et al.*, 2000 and Singh, 2001**).

The application of BA improved fruit set, fruit number and fruit weight through its benefit in enhancing cell enlargement and promote carbohydrate metabolism (**George *et al.*, 2008; Moatshe *et al.*, 2011; Amini *et al.*, 2013**; **Ghazzawy, 2013**; **Anita *et al.*, 2015 and Ashour *et al.*, 2018).** Regarding GA, obtained data were in agreement with **Quinones 2011** and **Mahmoud, 2012** they found that GA improving fruit set and increasing yield. Moreover, **El-Sayed *et al.* ,2014; Mahmoud, 2016 and El-Badawy *et al.*,2017 reported** that the increments in fruit set and yield by spraying with VC might be attributed to the increase in leaf photosynthetic pigments content and consequently on photosynthesis process and led to an increase in carbohydrates content of the plant. **Palmieri and Giovinazzi, 2006** stated that in the presence of excess VC, the indole-acetic acid oxidation catalysis is apparently blocked.

The improvement on fruit physical and chemical characteristics during application of BA, GA and VC may be due to its benefit in enhancing cell enlargement, promote carbohydrate metabolism increased sink strength. These positive effects led to enhance the vegetative growth which led to improve the physical and chemical characteristics. These results are in harmony with those results obtained **George *et al.*, 2008; Moatshe *et al.*, 2011; Amini *et al.*, 2013**; **Ghazzawy, 2013**; **Anita *et al.*, 2015 and Ashour *et al.*, 2018.** They reported that the application of BA improved fruit length, fruit diameter, and fruit quality through its benefit in enhancing cell enlargement, promote carbohydrate metabolism increased sink strength. For GA, these results were in agreement with **Panigrahi and Strivastava , 2011; Quinones, 2011** and **Mahmoud, 2012** They found that GA improving fruit quality . For VC, these results are in harmony with those results obtained by **Mahmoud, 2016 and El-Badawy *et al.*,2017** who reported that using VC enhanced fruit quality**.**

CONCLUSION

Generally, it could be summarized that all the tested growth regulator substances showed significant differences over the control. Regarding, the highest values for vegetative growth, leaf chemical composition, fruit set, yield, fruit physical and chemical characteristics were obtained by BA 40 ppm in both seasons.

ACKNOWLEDGEMENTS

Deep gratitude is due to staff members of Hort. Res. Station at El-Kanater El-Khiria for their continuous help during research work.

REFERENCES

A.O.A.C. Association of Official Analytical chemists (1990). Official method of analysis, the A.O.A.C., Arlington, VA, U.S.A.

Abd El-Ghany, N. A. (2005). Fruit drop. Agric. J., 60(3): 21-22, Ministry of Agriculture- Egypt.

Abdel-Mohsen, M. A. and Kamel, H. M. (2015). Fruit set and quality of 'canino' apricot fruits as affected by spraying with yeast, growth regulators and micronutrients. J. Plant Production, Mansoura. Univ., 6 (8): 1431–1441.

Amini, S.; Jafarpour, M. and Golparvar, A. (2013). Effect of pulsing treatments (calcium chloride + sucrose and distilled water) with fixed hormonal treatments on postharvest quality of cut Gerbera flowers. Technical J. Engine. and Appl. Sci., 3(13):1120-1123.

Anita, R; Sepideh, K.; Roohangiz, N. and Mohammad, M. (2015). Effect of preharvest foliar application of benzyladenine and salicylic acid on Carnation cv. spray and standard. Biological Forum and Intern. J., 7(2): 955-958.

Ashour, N. E.; Mostafa, E. A. M.; Malaka, A. Saleh and Omaima, M. Hafez (2018). Effect of GA, 6-benzylaminopurine and boric acid spraying on yield and fruit quality of barhee date palm. Middle East J. Agric. Res., 7 (2): 278-286.

Ben –Arie, R. and Guelllat-Reich, S. (1973). The effect of maturity at harvest on the Keeping quality of "Fuyu" Persimmon. I.T.R. Commission C2 Jerusalem 3, Israel.

Bremner, P. M. and Taha, M. A. (1966). Studies in potato agronomy 1- The effects of variety, seed size and spacing on growth, development and yield. J. Agric. Sci., 66: 241-252.

Brown, J. D. and Lilliland, O. (1964). Rapid determination of potassium and sodium in plant material and soil extracts by flame-photometry. Proc. Amer. Soc. Hort. Sci., 48: 341-346.

Duncan, D. B. (1958). Multiple range and multiple "F" test. Biometrics,11, 1- 42.

El-Badawy, H. E. M. (2013). Effect of some antioxidants and micronutrients on growth, leaf mineral content, yield and fruit quality of Canino apricot trees. Journal of Applied Sciences Research, 9(2), 1228-1237.

El-Badawy, H. E. M.; El-Gioushy, S. F.; Baiea, M. H. M.; El-Khwaga, A. A. (2017). Impact of Citric

Acid, Ascorbic Acid and Some Nutrients (Folifert, Potaqueen) on Fruit Yield and Quality of Washington Navel Orange Trees. Asian J. Adva. Agric. Res., 4(3): 1-13.

El-Sayed, Omima M.; El-Gammal, O. H. M. and Salama, A. S. M. (2014). Effect of ascorbic acid, proline and jasmonic acid foliar spraying on fruit set and yield of Manzanillo olive trees under salt stress. Scientia Horticulturae, 176: 32–37.

El-shaikh, A. A.; Khalil, B. M. and Hamza, A. Y. (1999). The effect of girdling and some growth regulators on fruit drop of Persimmon. Egypt. J. Agric. Res., 77(4): 1707-1724.

Fathi, M. A.; Azza I. Mohamed and Abd El-Bary, A. (2011). Effect of Sitofex (CPPU) and GA Spray on fruit set, fruit quality, yield and monetary value of "Costata" Persimmon. Nature and Science, 9(8): 40-49.

George; E. F.; Machakova, L. and Zazimalova, E. (2008). Plant propagation by tissue culture 3rd edition, 175-205.

Ghazzawy, H. S. (2013). Effects of some applications with growth regulators to improve fruit physical chemical characteristics and storage ability of Barhee Date palm cultivar. International research Journal of plant science, 4 (7): 208- 213.

Guirguis, N. S.; Attala, E. S.; Mikhael, G. B.; Gabr, M. A. (2010). Effect of Sitofex (CPPU) on fruit set, yield and fruit quality of "Costata" Persimmon trees, J. Agric. Res. Kafer EI-Shiekh Univ., 36(2): 206-219.

Mahmoud, T. A. (2012). Effect of some irrigation and growth regulator treatments on growth and fruiting of Washington navel orange trees. Ph. D. thesis, Faculty of Agriculture, Zagazig University, Egypt, 208.

Mahmoud, T. A. (2016). Effect of foliar sprays with ascorbic acid on flowering, fruit set and yield of Washington navel orange trees. J. Plant Production, Mansoura Univ., 7 (5): 519–529.

Mazher, Azza A. M.; Sahar M. Zaghloul; Safaa A. Mahmoud and Hanan S. Siam (2011). Stimulatory Effect of Kinetin, Ascorbic acid and Glutamic Acid on Growth and Chemical Constituents of *Codiaeum variegatum* L. Plants. American-Eurasian J. Agric. & Environ. Sci., 10 (3): 318-323.

Ministry of Agriculture and Land Reclamation (2017). Agricultural, Economics. Annual report, Cairo, Egypt.

Moatshe, O. G.; Emongor, V. E. and Oagile, O. (2011). Effect of benzyladenine (BA) on fruit set and mineral nutrition of morula (*Sclerocarya birrea* subspecies caffra). African J. Plant Sci., 4: 268-272.

Naguib, M. L. (1969). Colorimetric determination of nitrogen components of plant tissues. Bull. Fac. Agric. Sci., Cairo Univ., 43,1-5.

Palmieri, S. and Giovinazzi, F. (2006). Ascorbic acid as negative effector of the peroxidase-catalyzed degradation of indole-3-acetic acid. Physiologia Plantarum, 56 (1): 1–5.

Panigrahi, P. and Strivastava, A. K. (2011). Deficit irrigation (DI) scheduling for mature Nagpur mandarin (*Citrus reticulata* Blanco) trees of central India. Indian J. Soil Conservation, 39 (2): 149-154.

Price C. E. (1966). Ascorbate stimulation of RNA synthesis. Nature, 212(5069),1481-1481.

Quinones, A.; Martinez-Alcantara, B.; San-Francisco, S.; Garcia-Mina, J. M. and Legaz, F. (2011). Methyl xanthine as a potential alternative to gibberellic acid in enhancing fruit set and quality in clementine citrus trees in Spain. Experimental Agriculture, 47(1): 159-171.

Rao, M. V.; Koch, J. R. and Davis, K. R. (2000). Ozone as a tool for probing programmed cell death in plants. Plant Mol. Bio., 44: 346-356.

Saleem, B. A.; Malik, A. U.; Pervez, M. A. and Khan, A. S. (2008). Growth regulators application affects vegetative and reproductive behaviour of 'Blood Red' sweet orange. Pakistan J. Botany, 40 (5): 2115-2125.

Serrani, J. C.; Sanjuán, R.; Ruiz-Rivero, O.; Fos, M. and García-Martínez, J. L. (2007). Gibberellin regulation of fruit set and growth in tomato. Plant Physiol., 145(1): 246–257.

Shinde B. B.; Ingle, H. V.; Dhawale, D. U.; Hajare, A. R. and Dhobe, S. G. (2008). Effect of plant growth regulators on size, yield and quality of acid lime. J. Soils and Crops, 18 (1): 117-120.

Singh, D. V.; Srivastava, G. C. and Abdin, M. S. (2001). Amelioration of negative effect of water stress in Gassia angustifolia by benzyladenine abd / or ascorbic acid. Bidoyia plantarum, 4491: 141-143.

Snedecor, G. W. and Corchran, W. G. (1972). Statistical Methods, 6th Ed. lowa State Univ., Amess. lowa.

Westwood, M. N. (1993). Temperate-zone pomology: Physiology and culture, p. 523.