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Effect of foliar application with putrescine, salicylic and ascorbic acid on vegetative growth, leaf chemical composition, flowering and fruit set of Picual olive trees

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ABSTRACT

This study was carried out during 2017 and 2018 seasons on adult Picual olive cv. (8 years old) in a private orchard located at Ismailia Governorate, Egypt. Trees are grown in sandy soil, under drip irrigation system, uniform in shape and received the common horticultural practices, therefore, this work aims to study the effect of spraying different concentrations and dates spray of putrescine, salicylic and ascorbic acid for two times on vegetative growth, leaf chemical composition and flowering of Picual olive trees. Results indicated that all different spraying treatments at different spraying dates had a positive effect on vegetative growth, leaves mineral contents and flowering in comparison with the control. Treatment of putrescine at 15 ppm + salicylic acid at 200 ppm + ascorbic acid at 2000 ppm were the most effective treatments to increase vegetative growth, leaves minerals content, flowering and final fruit set. Thus, these treatments can be recommended for commercial use under similar conditions.

***Keywords*:** Olive trees, picual, putrescine, salicylice acid, ascorbic acid, vegetative growth, leaf pigments, leaf mineral content, flowering, fruit set.

Introduction

Olive tree (*Olea europaea* L.) is one of the oldest agricultural crops of remarkable economic and cultural importance in the Mediterranean Basin, it also represents as a widely distributed fruit tree in the world. According to statistical of Food and Agriculture Organization (FAO, 2017), the world area cultivated with olive trees in 2017 is about 10,804,517 hectares and world production of olive is 20,872,788 tons, most of which is extracted to olive oil and the rest processed mainly to table olive. The olive is an evergreen tree, belongs to family Oleaceae and includes many cultivars which are used for pickling and oil extraction. Picual olive cv. was introduced from Spain to Egypt and considered one of the best and main widely planted cultivar in Egypt.

Concerning putrescine, it is one of the polyamines (aliphatic amine) that are considered growth substances. Putrescine participates in several processes of plant growth and development and its role as anti-stress and anti-senescence agent is previously reported (Ahmed *et al.,* 2017). It works as antioxidant and improves cell membrane stability (Li *et al.,* 2015). In addition, particularly in 'Comice' pear, putrescine improved pollen tube ovule penetration and delayed ovule senescence without affecting flower ethylene production (Crisosto *et al.,* 1992). It plays role in modulating the defense response of plants to varied environmental stresses including drought stress (Ahmed *et al.*, 2013) and (Khorshidi & Hamedi 2014). Using the foliar application with putrescine on trees improved vegetative growth of different crops (Franco-Mora *et al.,* 2005) on pear trees and (Talaie *et al.,* 2010) on pistachio trees. Moreover, Salicylic acid is a controller for many metabolites physiological activities in plants (Brar *et al.,* 2014), salicylic acid is a signaling phytohormone with diverse regulatory roles in plant metabolism and abiotic stress tolerance, also it incease flowering and yield of crops (Khan *et al.,* 2015). Martinez *et al.,* (2004) approved that salicylic acid enhance plant stress resistance, and it has used widely due to its valuable role in plant stress resistance against abiotic stresses. Abd El-Razek *et al.,* (2013) found that using salicylic acid foliar application at 40 µg/L for improving yield of olive trees cv. Egazy, owing to it increased blooming, pollen grains development and enhancement fruit features. Other effects of salicylic acid were observed on maintaining fruit firmness, reduced chilling injury incidence, and delayed membrane lipid peroxidation (Khademi and Ershadi, 2013). Meanwhile, Ascorbic acid has

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auxinic action and synergistic effect on flowering and fruiting of most fruit trees, recently antioxidants used instead of auxins and other chemicals for enhancing growth and fruiting of various fruit trees (Ragab 2002). In addition, the positive action of antioxidants in catching or chelating the free radicals that could result in extending the shelf life of plant cells and stimulating growth aspects is reported (Rao *et al*., 2000). Ascorbic acid is considered as natural and organic antioxidant compound (Hafez *et al.,* 2010), as well as it is considered as an essential compound for plant tissues since it has antioxidant functions, and acts as co-enzyme in an enzymatic cofactor and plant growth regulator (Gomez and Lajolo 2008). It has synergistic effect on improving growth, flowering and yield of crops (Maksoud *et al.,* 2009) on olive trees, (Ahmed *et al.,* 2011) on grapvines and (El-Badawy 2013) on apricot trees.

Material and Methods

This study was carried out during two successive seasons (2017 and 2018) in a private orchard located at Cairo-Ismailia Desert Road (about 80 Km from Cairo), Ismailia governorate, Egypt. The study was conducted on 8 years old olive trees of Picual cv., planted at 4 X 6 m apart grown in sandy soil, under drip irrigation system. The selected trees were uniformed in shape and received the common horticultural practices. The orchard soil analysis are given in table (1) and the water irrigation analysis are given in table (2) according to procedures which are outlined by Wild, *et al.* (1985).

Table 1: Some physical and chemical properties of the orchard soil:

parameters	Surface sample	Depth of simple (cm) 30 cm depth	60 cm depth
pH	8.02	8.70	8.11
EC(dSm-1)	3.80	0.80	1.70
		Soluble cations (meq\l)	
Ca^{++}	6.00	2.50	3.00
Mg^{++}	4.00	1.50	1.50
Na^{+}	28.60	4.40	12.90
K^{+}	0.12	0.14	0.78
		Soluble anions (meq\l)	
CO_3^{-}	-	-	-
HCO_3^{-}	4.40	2.40	2.00
Cl^{-}	27.20	5.00	13.00
$SO_4^{=}$	7.12	1.14	3.18

Table 2: Chemical characteristics of the used water well for the present study

Parameters	Values
pH	7.49
EC(dSm^{-1})	4.40
Soluble cations (meq/l)	
Ca++	7.50
Mg++	5.00
Na+	33.1
K+	0.16
Soluble anions (meq/l)	
CO_3^{-2}	-
HCO_3^{-}	1.60
Cl^{-}	40.00
SO_4^{-2}	4.16

This experiment was designed to study the effect of spraying Picual olive trees with putrescine, salicylic acid and ascorbic acid at different concentrations and dates i.e. mid of November and mid of December (33 trees for each date) during two studied seasons as follow:
(Cont) Control treatment (spray with water only)
T1-Tree spray with putrescine (PUT) at 15 ppm.
T2-Tree spray with putrescine at 30 ppm.
T3-Tree spray with salicylic acid (SAL) at 200 ppm.

T4-Tree spray with salicylic acid at 300 ppm.
T5-Tree spray with ascorbic acid (ASC) at 2000 ppm.
T6-Tree spray with ascorbic acid at 3000 ppm.
T7-Tree spray with PUT at 15 ppm + SAL at 200 ppm.
T8-Tree spray with PUT at 15 ppm + ASC at 2000 ppm.
T9-Tree spray with SAL at 200 ppm + ASC at 2000ppm.
T10-Tree spray with PUT 15 ppm+ SAL 200 ppm+ ASC 2000 ppm.

Both group of trees which sprayed at November or December received other two spraying dates i.e. the first at full bloom (during April) and the second after fruit set (during May). Each treatment was represented by three replicates (one tree per replicate) which were chosen randomly and on early October of each season, twenty healthy one-year old shoots well distributed around the canopy were randomly selected and labeled (5 shoots for each direction) for carrying out the following measurements:

Vegetative parameters: At the end of each growing season, during first week of September the following characteristics were measured.
1- Shoot length (cm)
2- Number of leaves per shoot
3- Leaf area (cm^2) according to Ahmed and Morsy (1999) using the following equilibration:

Leaf area = 0.53 (length x width) + 1.66.

Leaf mineral content and pigments

Leaves needed were randomly sampled from the previously labeled shoots per each tree / replicate on the second week of September. Whereas, 2 - 3 leaves from every shoot (4th and 5th leaves from the shoot base) were picked then mixed together as a composite for carrying out the following chemical analysis:

1. Leaf pigments

Pigments i.e., chlorophyll a, b & carotene as mg/g were colormetrically determined in fresh leaf samples at wave length of 660, 640 and 440 nm for a, b & carotene respectively according to Wettestien, (1957).

2. Leaf mineral content

Leaf sample from each tree / replicate was separately oven dried at 70ºc till constant weight, and then grounded for determination the following nutrient elements (Percentage as dry weight):
Nitrogen: Using the modified micro -kjeldahl method as lined by Pregl, (1945).
Phosphorus: Was estimated as described by Chapman and Pratt, (1961).
Potassium: Flamephotometerically determined according to Brown and Lilleland, (1946).
Iron and Zinc as ppm was spectrophotometerically determined using atomic absorption (Model, spectronic 21 D) as described by Jackson. (1973).

Flowering characteristics
1. Flowering density: Number of inflorescences per meter on the labeled twenty shoots was calculated.
2. Number of total flowers per inflorescence: Sample of 20 inflorescences was taken from every tree and total number of flowers per inflorescences was counted.
3. Sex ratio: The percentage of perfect flowers to total flowers was calculated for every replicate.
Fruit set and fruit drop: fruit set percentage as number of fruits / meter at two times first after 20 days from full bloom as initial fruit set and the second 60 days after full bloom as final fruit set according to Fernandez and Gomez, (1985).

Final fruit set & fruit drop percentages were estimated as follows:
Initial fruit set (%) = [Number of fruit set (20 days after full bloom) / shoot length (cm)] × 100
Final fruit set (%) = [Number of fruit set (60 days after full bloom) / shoot length (cm)] × 100
Fruit drop (%) = [(Initial fruit set - Final fruit set) / Initial fruit set] × 100.

Experimental Design and Statistical Analysis:

All obtained data during both 2017 and 2018 experimental seasons were subjected to analysis of variances (ANOVA) according to Snedecor and Cochran, (1980) using MSTAT program. Least significant ranges (LSR) were used to compare between means of treatments according to Duncan, (1955) at probability of 5 %.

Results and Discussion

Vegetative growth

Data cleared in the Table (3) indicated that, shoot length was significantly affected by spraying putrescine, salicylic acid and ascorbic acid individually or in combination at both spraying dates in two studied seasons. Tree sprayed with PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm (T10) recorded the largest shoot length (26.40 and 25.11 cm) in the first and second seasons respectively. Furthermore, the control trees gave the minimum of shoot length (23.81 and 19.75 cm) during the first and second seasons, secuently. Regarding the time of foliar application it observed that no significant differences between spraying dates in the first season, but December foliar application date was significantly higher value (22.63 cm) than November (21.94 cm) in the second season. As for interaction effect tree spray with PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm (T10) in December recorded the largest values in this regard (27.00 and 26.31 cm) in both studied seasons, severally.

Results in the Table (3) revealed that, all different treatments increased number of leaves per shoot as compared with control treatment. Tree sprayed with PUT at 15 ppm + SAL at 200 ppm (T7) and PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm (T10) recorded the maximum values (35.40 and 35.12) in the first season, respectively. Furthermore, spraying by ASC at 3000 ppm (T6) and PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm (T10) recorded the highest values in this respect (43.76 and 43.61), consecutive. On the other hand, foliar spraying with SAL at 200 ppm (T3) gave the lowest value (28.47) in the first season. Meanwhile, the lowest values were under control treatment (32.43) in the second seasons. On the other side, in respect to the time of foliar application it observed that no significant differences between spraying dates in the first season, but in the second season, December application date was significantly higher value (40.29) than November (38.37). As for interaction effect, trees sprayed with PUT at 15 ppm + SAL at 200 ppm (T7) in November and SAL at 200 ppm + ASC at 2000 ppm (T9) recorded the highest value in this respect (37.00 and 44.20) in the two studied seasons, respectively

Results in Table (3) showed that, all different treatments increased leaf area as compared with control treatment. As for tree sprayed with PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm (T10) and tree sprayed with SAL at 300 ppm (T4) recorded the highest values in this respect, since it was (4.20 and 4.86 cm^2) in the first and second seasons, respectively. Meanwhile, the lowest leaf area was observed with PUT at 15 ppm (T1) and with untreated trees (control) scene it was 3.67 and 3.73 cm^2 in the first and second seasons, respectively. Regarding the time of foliar application it observed that no significant differences between spraying dates in the first season, meanwhile in the second season November spraying date was significantly higher value (4.38 cm^2) than December one (4.28 cm^2) in this respect. Concerning interaction effect, trees sprayed with PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm (T10) in December recorded the highest significant value (4.36 cm^2) in the first season. On the other hand, trees sprayed with SAL at 300 ppm (T4) and PUT at 15 ppm + SAL at 200 ppm (T7) in November scored the highest value in this respect since it was (5.10 and 4.95 cm^2) in the second season.

The significant effect of conducted treatments may be due to auxinic action of ascorbic acid on enhancing cell division and cell enlargement which reflected positively on leaf area was concluded by (Omar 1999). Also, polyamines such as putrescine are purported to be involved in stress tolerance, cell division and morphogenesis (Liu *et al.,* 2006). So, the beneficial effects of salicylic acid in enhancing the tolerance of fruit crop species to stresses and the biosynthesis of sugars, amino acid and plant pigments and the promoting effect of salicylic acid on cell division could explain the present results (Joseph et al., 2010). This results are in agreement with obtained by El-Badawy (2013) who found that ascorbic acid at 2000 ppm obtain the highest number of leaves/shoot, shoot length and leaf area on apricot trees. In addition, Omima *et al.,* (2014) found that ascorbic acid at 3000 ppm at three times

Table 3: Influence of foliar applications with putrescine, salicylic and ascorbic acid on vegetative growth of Picual olives in 2017 and 2018 seasons.

Treat.	Shoot length (cm)						No. of leaves / shoot					
	2017			2018			2017			2018		
	Spraying date		Mean	Spraying date		Mean	Spraying date		Mean	Spraying date		Mean
	Nov.	Dec.		Nov.	Dec.		Nov.	Dec.		Nov.	Dec.	
Cont.	23.63 d	23.99 cd	23.81 C	20.00 n	19.50 o	19.75 I	32.87c-f	33.83bcd	33.35 BC	32.07 m	32.80 l	32.43 J
T1	24.91 bcd	25.04bcd	24.68 B	19.51 o	22.50 i	21.01F	31.25dg	30.42efg	30.83 DE	38.79 h	39.75 g	39.27E
T2	25.83 ab	25.90 ab	25.87AB	22.00 k	19.12 p	20.56G	30.92efg	33.00cde	31.96CDE	32.75 l	35.00 j	33.87 I
T3	24.86 bcd	26.00 ab	25.43AB	22.60 i	20.50 m	21.55E	24.42 h	32.53 c-f	28.47 F	34.00 k	40.25 ef	37.12H
T4	25.00 bcd	25.54abc	25.27AB	22.12 j	23.80 e	22.96C	30.51efg	32.90cde	31.70CDE	34.75 j	42.00 d	38.37G
T5	25.87 ab	24.80bcd	25.34AB	22.50 i	25.61 b	24.05B	34.25 bc	32.34 c-f	33.29 BC	40.00 fg	43.40 c	41.70C
T6	26.41 ab	25.53abc	25.97AB	23.20 g	25.00 c	24.10B	36.00 ab	28.86 g	32.43BCD	43.75 b	43.76 b	43.76A
T7	26.18 ab	25.83 ab	26.01AB	19.00 q	21.10 l	20.05H	37.00 a	33.80bcd	35.40 A	40.50 e	40.23 ef	40.36D
T8	24.83 bcd	25.21bcd	25.02 B	23.56 f	20.49 m	22.02D	30.55efg	30.26 fg	30.70 E	38.00 i	40.10 f	39.05F
T9	25.78 ab	24.75bcd	25.27AB	23.00 h	25.07 c	24.03B	31.77c-f	35.83 ab	33.80 AB	44.20 a	42.00 d	43.10B
T10	25.80 ab	27.00 a	26.4 A	23.92 d	26.31 a	25.11A	34.00 bc	36.25 ab	35.12 A	43.30 c	43.93 ab	43.61A
Mean	**25.37 A***	**25.42A***		**21.94B***	**22.63A***		**32.14A***	**32.73A***		**38.37B***	**40.29A***	

Treat.	No. of leaves / shoot					
	2017			2018		
	Spraying date		Mean	Spraying date		Mean
	Nov.	Dec.		Nov.	Dec.	
Cont.	3.71 gh	3.76 fgh	3.73 DE	3.73 b	3.74 b	3.73 K
T1	3.56 i	3.78 fgh	3.67 E	4.09 ab	4.14 ab	4.11 I
T2	3.80 efg	3.71 gh	3.75 D	4.14 ab	4.69 ab	4.41 E
T3	3.71 gh	3.99 cd	3.85 C	4.41 ab	4.19 ab	4.30 G
T4	3.75 fgh	3.85 ef	3.81 CD	5.10 a	4.61 ab	4.86 A
T5	3.90 de	3.68 h	3.79 CD	4.14 ab	4.57 ab	4.35 F
T6	4.20 b	3.77 fgh	3.99 B	4.57 ab	4.41 ab	4.49 C
T7	4.04 c	3.97 cd	4.01 B	4.95 a	4.19 ab	4.57 B
T8	4.04 c	3.91 de	3.98 B	4.36 ab	3.76 b	4.06 J
T9	3.99 cd	4.04 c	4.02 B	4.03 ab	4.51 ab	4.27 H
T10	4.04 c	4.36 a	4.20 A	4.62 ab	4.33 ab	4.48 D
Mean	**3.90 A***	**3.89 A***		**4.38 A***	**4.28 B***	

Mean in each column, row or interaction with similar letter(s) are not significantly different at 5 % level.
T1 = PUT at 15 ppm, **T2 =** PUT at 30 ppm, **T3 =** SAL at 200 ppm, **T4 =** SAL at 300 ppm, **T5 =** ASC at 2000 ppm, **T6 =** ASC at 3000 ppm, **T7** = PUT at 15 ppm + SAL at 200 ppm, **T8=** PUT at 15 ppm + ASC at 2000 ppm**, T9=** SAL at 200 ppm + ASC at 2000 ppm**, T10=** PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm.

Table 4: Influence of foliar applications with putrescine, salicylic and ascorbic acid on leaf pigments content of Picual olives in 2017 and 2018 seasons.

Treat.	Chlorophyll A (mg.g^{-1})						Chlorophyll B (mg.g^{-1})					
	2017			2018			2017			2018		
	Spraying date		Mean	Spraying date		Mean	Spraying date		Mean	Spraying date		Mean
	Nov.	Dec.		Nov.	Dec.		Nov.	Dec.		Nov.	Dec.	
Cont.	1.31 fg	1.33 f	1.32 G	1.32 j	1.32 j	1.32 F	0.46 bc	0.47 bc	0.47 G	0.48 c	0.47 c	0.48 G
T1	1.57 d	1.44 e	1.51 D	1.57 g	1.44 i	1.50 D	0.58 abc	0.56 abc	0.57 E	0.58 abc	0.56 abc	0.57 E
T2	2.05 b	1.33 f	1.69 BC	2.08 c	1.33 j	1.70 B	0.71 abc	0.51 bc	0.61 D	0.71 abc	0.52 bc	0.62CD
T3	1.49 de	1.26 fg	1.38 F	1.49 hi	1.33 j	1.41 E	0.56 abc	0.48 bc	0.52 F	0.56 abc	0.56 abc	0.56 E
T4	2.33 a	1.57 d	1.95 A	2.30 a	1.57 g	2.02 A	0.88 a	0.57 abc	0.73 A	0.82 a	0.57 abc	0.71 A
T5	1.48 e	1.82 c	1.65 C	1.48 hi	1.75 f	1.61 C	0.54 abc	0.69 abc	0.62 D	0.54 abc	0.66 abc	0.60 D
T6	1.42 e	2.02 b	1.72 B	1.49 hi	1.94 d	1.72 B	0.54 abc	0.74 abc	0.64 C	0.55 abc	0.72 abc	0.63 C
T7	2.04 b	1.83 c	1.93 A	2.23 b	1.82 e	2.03 A	0.68 abc	0.65 abc	0.67 B	0.78 ab	0.65 abc	0.69 B
T8	1.24 g	1.11 h	1.18 H	1.24 k	1.32 j	1.28 F	0.50 bc	0.38 c	0.40 I	0.50 bc	0.52 bc	0.51 F
T9	0.96 i	1.07 h	1.02 I	1.31 j	1.34 j	1.32 F	0.37 c	0.42 bc	0.44 H	0.51 bc	0.54 abc	0.52 F
T10	1.30 fg	1.57 d	1.44 E	1.30 jk	1.51 gh	1.41 E	0.52 bc	0.51 bc	0.51 F	0.52 bc	0.54 abc	0.53 F
Mean	**1.57 A***	**1.49 B***		**1.63 A***	**1.52 B***		**0.58 A***	**0.55 B***		**0.60 A***	**0.57 B***	

Treat.	Carotene (mg.g^{-1})					
	2017			2018		
	Spraying date		Mean	Spraying date		Mean
	Nov.	Dec.		Nov.	Dec.	
Cont.	0.41 bcd	0.41 bcd	**0.41 E**	0.67 bcd	0.66 bcd	**0.66 H**
T1	0.41 bcd	0.39 d	**0.40 E**	0.76 a-d	0.79 a-d	**0.77 F**
T2	0.43 abcd	0.47 abcd	**0.45 C**	0.94 ab	0.76 a-d	**0.85 B**
T3	0.41 bcd	0.40 cd	**0.40 E**	0.77 a-d	0.65 bcd	**0.71 G**
T4	0.42 abcd	0.44 abcd	**0.43 D**	0.98 a	0.71 a-d	**0.84 B**
T5	0.51 ab	0.43 abcd	**0.47 B**	0.78 a-d	0.84 a-d	**0.81 C**
T6	0.43 abcd	0.50 abc	**0.46 B**	0.79 a-d	0.86 abc	**0.83 C**
T7	0.47 abcd	0.39 d	**0.44 D**	0.98 a	0.77 a-d	**0.87 A**
T8	0.46 abcd	0.44 abcd	**0.45 C**	0.72 a-d	0.56 d	**0.64 I**
T9	0.53 a	0.49 abcd	**0.51 A**	0.80 a-d	0.60 cd	**0.70 G**
T10	0.44 abcd	0.47 abcd	**0.45 C**	0.80 a-d	0.78 a-d	**0.79 E**
Mean	**0.45 A***	**0.44 A***		**0.82 A***	**0.73 B***	

Mean in each column, row or interaction with similar letter(s) are not significantly different at 5 % level.

T1 = PUT at 15 ppm, **T2** = PUT at 30 ppm, **T3** = SAL at 200 ppm, **T4** = SAL at 300 ppm, **T5** = ASC at 2000 ppm, **T6** = ASC at 3000 ppm, **T7** = PUT at 15 ppm + SAL at 200 ppm, **T8**= PUT at 15 ppm + ASC at 2000 ppm**, T9**= SAL at 200 ppm + ASC at 2000 ppm**, T10**= PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm.

showed to be most efficient treatment on leaf area values of Manzanillo olive trees. Also, on mango trees, Hanan (2015) found that spraying by 1Mm ascorbic acid + 2 Mm salicylic acid gave the highest leaf area. In this manner, Randa (2015) reported that foliar spraying by salicylic acid at 400 ppm once or twice considerably improved shoot length, shoot diameter and leaf area compared with other concentrations. Also, on Manzanillo olive trees, Abd-El-Rhman and Attia (2016) they reported that spraying by salicylic acid at 1000 ppm gave the highest shoot length, leaf area and number of leaves per shoot. On the other hand, Shaimaa *et al.,* (2018) they elucidate the most of plant height, stem diameter, leaves number per plant and leaf area were given with the lowest concentrations of putrescine.

Leaf pigments

Concerning leaf content of chlorophyll A in Table (4), results showed that, different treatments led to significant increase in leaf content of chlorophyll A in both study seasons. Spraying with SAL at 300 ppm (T4) and PUT at 15 ppm + SAL at 200 ppm (T7) produced the maximum values in the first season (1.95 and 1.93 mg/g) and in the second season (2.02 and 2.03 mg/g), respectively. While, trees sprayed with SAL at 200 ppm + ASC at 2000 ppm (T9) recorded the least value (1.02 mg/g) in the first season, but in the second one the lowest leaf content of chlorophyll A cleared with PUT at 15 ppm + ASC at 2000 ppm (T8) and with untreated trees (control) since it was (1.28 and 1.32 mg/g), respectively. As for spraying dates, November spray recorded the higher value (1.57 and 1.63 mg/g) as compared with December one (1.49 and 1.52 mg/g) in the first and second seasons, respectively. Concerning the interaction effect, spraying trees with SAL at 300 ppm (T4) in November gave the highest values (2.33 and 2.30 mg/g) in this regard in both study seasons, sequently.

Results in Table (4) showed that, leaf content of chlorophyll B was significantly affected with all treatments in two studied seasons. As for tree sprayed with SAL at 300 ppm (T4) recorded the maximum values (0.73 and 0.71 mg/g) in both studied seasons. Meanwhile, the lowest one was under PUT at 15 ppm + ASC at 2000 ppm (T8) and the control treatment since it was (0.44 and 0.48 mg/g) during the first and second seasons, sequently. Regarding the time of foliar application it observed that November spraying date was significantly higher value (0.58 and 0.60 mg/g) than December one (0.55 and 0.57 mg/g) in the first and second seasons, consecutive. Concerning interaction effect, trees sprayed with SAL at 300 ppm (T4) at November recorded the highest significant values (0.88 and 0.82 mg/g) in both study seasons, respectively.

Results presented in Table (4) revealed that, leaf content of carotene was affected with all different treatments compared with the control. Trees received SAL at 200 ppm + ASC at 2000 ppm (T9) and PUT at 15 ppm + SAL at 200 ppm (T7) gave the maximum leaf content of carotene (0.51 and 0.87 mg/g) in the first and second seasons, respectively. On the other hand, spraying with PUT at 15 ppm (T1) and SAL at 200 ppm (T3) gave the minimum values (0.40 and 0.40 mg/g) in the first season. Meanwhile, spraying with PUT at 15 ppm + ASC at 2000 ppm (T8) exhibited the minimum leaf content of carotene (0.64 mg/g) in the second one. In addition, the other treatments recorded intermediate values in this respect. Regard to spraying date, results showed that no significant differences between spraying dates in the first season, meanwhile in the second one November spraying date was significantly higher value (0.82 mg/g) than December one (0.73 mg/g) in this regard. As for interaction effect between the concentration treatments and spraying dates, results showed that tree sprayed with SAL at 200 ppm + ASC at 2000 ppm (T9) in November recorded higher values in this respect (0.53 mg/g) in the first season, however tree sprayed with SAL at 300 ppm (T4) in November and PUT at 15 ppm + SAL at 200 ppm (T7) In November gave the highest values (0.98 and 0.98 mg/g) in the second season.

There results are in agreement with Omima *et al.,* (2014) cleared that spray olive trees "Manzanillo cv." with 3000 ppm ascorbic acid at tree times a year enhanced total chlorophyll content in leaves. In the same respect, on Royal apricot trees (*Prunus armeniaca* L.), Mosleh *et al*., (2014) reported that foliar spraying of ascorbic acid at 300 mg/L gave the highest values of total chlorophyll content in the apricot leaves. Also, Mayi *et al.,* (2014) showed that foliar application of ascorbic acid at 1000 increased significantly total chlorophyll percentage of leaves on two olive transplants cultivars (Sorany and Khithairy) compared with untreated olive transplants. Therefore, Abdel Aziz *et al.,* (2017) found that spraying by 100 or 200 ppm salicylic acid at three times increased leaf chlorophyll a & b, and carotenoids contents on pomegranate trees. On the other side, Shaimaa *et al.,* (2018) clearly showed that spraying with putrescine (at 150 ppm) at first of June and July improved total chlorophyll content and carbohydrates content of leaves sour orange seedless.

Leaf mineral contents

Results in Table (5) showed that, the most treatments led to significant increase in leaf percentage of nitrogen in both seasons. Spraying with PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm (T10) produced the highest significant values (1.90 and 1.86%) in the first and second seasons, respectively, while PUT at 15 ppm (T1) and the control treatment recorded the least values in this regard (1.57 and 1.53%) in the first and second seasons, respectively. As for spraying dates, November spraying date recorded the maximum nitrogen percentage (1.76 and 1.71%) as compared with December one (1.71 and 1.68%) in both study seasons, respectively. Regarding the interaction effect, spraying trees with ASC at 3000 ppm (T6) in December gave the highest value (1.97%) in this respect in the first season, while in the second one, trees sprayed with PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm (T10) in November exhibited the maximum leaf percentage of nitrogen (1.90%) and the other treatments were in between range.

Regard to leaf percentage of phosphorus, results in the Table (5) illustrated that, spraying trees with SAL at 200 ppm + ASC at 2000 ppm (T9) and PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm (T10) produced the highest percentages (0.255 and 0.254%) in this respect during the first season, moreover spraying trees with SAL at 300 ppm (T4) showed the highest value (0.260%) in the second season. On the other hand, in the first season the minimum leaf percentage of P cleared with untreated trees (control) since it was 0.209%, but sprayed with PUT at 15 ppm (T1) recorded the least value (0.208%) in the second season, Concerning the time of foliar application it observed that November spraying date was significantly higher value (0.235%) than December one (0.230%) in the first season, meanwhile in the second one, December spraying date was higher value (0.239%) than November one (0.232%) in this respect, respectively. Concerning interaction influence, results clear that no significant differences between the consent reaction and spraying date in both seasons of the study.

Results in the Table (5) reported that, the most different treatments increased leaf percentage of potassium as compared with untreated trees. Tree sprayed with PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm (T10) recorded the significant highest leaf percentage of potassium (1.63%) in the first season. Moreover, treated by PUT at 15 ppm + ASC at 2000 ppm (T8) gave the highest value (1.38%) in this ragard in the second season. Furthermore, control treatment gave the minimum of potassium percentage (1.21%) during the first season, whereas the lowest one was spraying by PUT at 15 ppm + SAL at 200 ppm (T7) gave the lowest value (1.12%) during the second season. On the other hand, the time of foliar application shows that November application date was significantly higher than December (1.47, 1.29%) and (1.46, 1.24%) in the first and second seasons, sequently. As for interaction effect, trees sprayed with PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm (T10) at December and PUT at 15 ppm + ASC at 2000 ppm (T8) recorded the maximum values in this respect (1.64 and 1.47%) in the first and second seasons, respectively**.**

It is clear from results in Table (6) that, all different spraying treatments significantly increased leaf iron basis than the control during both seasons. Trees sprayed with PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm (T10) obtained the maximum leaf iron (332.4 and 316.5 ppm) in the first and second seasons, consecutive. On the other contrary, trees sprayed with PUT at 13 ppm (T2) and the control treatment exhibited the least values (246.5 and 202.5 ppm) in the first and second seasons, respectively. Meanwhile, the other treatments were in between range. Regard to spraying date, results showed that December spray was significantly higher than November (306.9, 273.7% and 289.5, 250.2 ppm for both December and November in the first and second seasons, respectively). As for interaction effect between different concentration treatments and spraying dates, it could be concluded that, trees sprayed with ASC at 2000 ppm (T5) and ASC at 3000 ppm (T6) in December recorded the highest values (350, 355 ppm) in the first season and (325.6, 331.6 ppm) in the second seasons, consecutive. Compared with other treatments.

Regard to leaf content of zinc, results in the Table (6) showed that, most treatments affected leaf zinc than the control in both study seasons. In this concern, spraying trees with SAL at 300 ppm (T4) produced the highest values (32.23 and 34.53 ppm) in the first and second seasons, respectively. On the other hand, spraying trees with ASC at 3000 ppm (T6) gave the minimum leaf zinc in this respect (24.90 ppm) in the first season, while spraying by ASC at 2000 ppm (T5) recorded the lowest value (26.56 ppm) in the second season. Concerning spraying dates in December gave higher values (28.69 and 30.82 ppm) than November (27.94 and 28.69 ppm) in both study seasons, respectively.

Table 5: Influence of foliar applications with putrescine, salicylic and ascorbic acid on macro elements content of Picual olives in 2017 and 2018 seasons.

Treat.	N (%)						P (%)					
	2017			2018			2017			2018		
	Spraying date		Mean	Spraying date		Mean	Spraying date		Mean	Spraying date		Mean
	Nov.	Dec.		Nov.	Dec.		Nov.	Dec.		Nov.	Dec.	
Cont.	1.72 ab	1.72 ab	1.71 E	1.52 f	1.53 f	1.53 H	0.20 a	0.21 a	0.209 E	0.21 a	0.22 a	0.216FG
T1	1.64 ab	1.51 b	1.57 G	1.81 a-e	1.58 f	1.69DE	0.20 a	0.22 a	0.212 E	0.20 a	0.21 a	0.208 G
T2	1.84 ab	1.86 ab	1.85 B	1.85 ab	1.67 b-f	1.76 C	0.21 a	0.21 a	0.210 E	0.21 a	0.23 a	0.221EF
T3	1.68 ab	1.64 ab	1.66 F	1.63 c-f	1.56 f	1.59 G	0.20 a	0.23 a	0.214 E	0.22 a	0.24 a	0.235CD
T4	1.58 ab	1.74 ab	1.66 F	1.83abc	1.81 a-e	1.82 B	0.21 a	0.22 a	0.213 E	0.26 a	0.26 a	0.260 A
T5	1.84 ab	1.68 ab	1.76 D	1.61 ef	1.62 def	1.62 F	0.24 a	0.24 a	0.246 CD	0.21 a	0.22 a	0.215FG
T6	1.69 ab	1.97 a	1.83 C	1.67 b-f	1.72 a-f	1.69DE	0.25 a	0.24 a	0.249 BC	0.26 a	0.22 a	0.245BC
T7	1.73 ab	1.60 ab	1.66 F	1.67 b-f	1.72 a-f	1.69DE	0.25 a	0.25 a	0.252 AB	0.20 a	0.26 a	0.231DE
T8	1.88 ab	1.57 ab	1.72 E	1.68 b-f	1.69 a-f	1.68 E	0.24 a	0.24 a	0.242 D	0.26 a	0.24 a	0.251AB
T9	1.95 a	1.58 ab	1.76 D	1.68 b-f	1.73 a-f	1.7 D	0.25 a	0.26 a	0.255 A	0.25 a	0.26 a	0.256AB
T10	1.85 ab	1.95 a	1.90 A	1.90 a	1.82 a-d	1.86 A	0.26 a	0.25 a	0.254 A	0.26 a	0.26 a	0.258AB
Mean	**1.76 A***	**1.71 B***		**1.71 A***	**1.68 B***		**0.235A***	**0.230B***		**0.232B***	**0.239A***	

Treat.	K (%)					
	2017			2018		
	Spraying date		Mean	Spraying date		Mean
	Nov.	Dec.		Nov.	Dec.	
Cont.	1.21 bc	1.20 c	1.21 J	1.26 ab	1.27 ab	1.27 E
T1	1.33 abc	1.33 abc	1.33 I	1.23 ab	1.16 b	1.20 H
T2	1.61 a	1.34 abc	1.47 E	1.38 ab	1.22 ab	1.30 D
T3	1.39 abc	1.44 abc	1.41 G	1.33 ab	1.30 ab	1.32 C
T4	1.45 abc	1.56 ab	1.50 D	1.32 ab	1.28 ab	1.31 C
T5	1.33 abc	1.54 ab	1.44 F	1.33 ab	1.15 b	1.24 F
T6	1.64 a	1.59 ab	1.61 B	1.10 b	1.35 ab	1.22 G
T7	1.44 abc	1.28 abc	1.36 H	1.33 ab	1.15 b	1.12 I
T8	1.50 abc	1.55 ab	1.53 C	1.47 a	1.30 ab	1.38 A
T9	1.62 a	1.62 a	1.62 B	1.13 b	1.10 b	1.24 F
T10	1.63 a	1.64 a	1.63 A	1.33 ab	1.35 ab	1.34 B
Mean	**1.47 A***	**1.46 B***		**1.29 A***	**1.24 B***	

Mean in each column, row or interaction with similar letter(s) are not significantly different at 5 % level.
T1 = PUT at 15 ppm, **T2** = PUT at 30 ppm, **T3** = SAL at 200 ppm, **T4** = SAL at 300 ppm, **T5** = ASC at 2000 ppm, **T6** = ASC at 3000 ppm, **T7** = PUT at 15 ppm + SAL at 200 ppm, **T8**= PUT at 15 ppm + ASC at 2000 ppm**, T9**= SAL at 200 ppm + ASC at 2000 ppm**, T10**= PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm.

Table 6: Influence of foliar applications with putrescine, salicylic and ascorbic acid on micro elements content of Picual olives in 2017 and 2018 seasons.

Treat.	Fe (ppm)						Zn (ppm)					
	2017			2018			2017			2018		
	Spraying date		Mean	Spraying date		Mean	Spraying date		Mean	Spraying date		Mean
	Nov.	Dec.		Nov.	Dec.		Nov.	Dec.		Nov.	Dec.	
Cont.	295.0a-d	297.0a-d	296.0 G	201.2 c	203.7 bc	202.5 J	26.76abc	26.40abc	26.58 F	30.56 ab	30.26 ab	30.41DE
T1	244.0bcd	298.3a-d	271.2 I	206.6 bc	305.5abc	256.1 E	29.40abc	27.60abc	28.50 E	32.63 ab	31.90 ab	32.26 C
T2	242.1 cd	250.9a-d	246.5 K	264.4abc	248.5abc	256.4 E	24.93abc	25.93 bc	25.43 G	30.03 ab	31.80 ab	30.91 D
T3	317.8a-d	321.5abc	319.8 D	254.0abc	227.8abc	240.9 G	28.63abc	24.50 ab	26.56 F	31.83 ab	25.60 b	28.71 G
T4	294.4a-d	229.2 ab	316.8 E	265.6abc	234.4abc	250.0 F	32.36 ab	32.10abc	32.23 A	34.20 ab	34.86 ab	34.53 A
T5	277.1a-d	350.0 a	313.5 F	241.1abc	325.6 a	283.4 D	24.80abc	29.50 ab	27.15 F	25.63 b	27.50 ab	26.56 I
T6	299.9a-d	355.4 a	327.6 C	243.2abc	331.6 a	283.4 C	28.10abc	30.36abc	24.90 G	25.90 b	33.70 ab	29.80EF
T7	319.7a-d	234.6a-d	277.1 H	222.8abc	255.6abc	239.2 H	30.56 ab	28.40abc	29.23 D	27.46 b	27.93 ab	27.70 H
T8	229.0 d	271.5a-d	250.3 J	238.4abc	238.0abc	238.2 I	21.10 c	28.70abc	29.48CD	25.96 b	28.20 ab	27.08HI
T9	332.3 de	326.6a-d	329.5 B	304.7abc	316.6 ab	310.6 B	29.70 ab	33.33 a	31.51 B	28.40 ab	37.60 a	33.00 B
T10	333.3a-d	331.5a-d	332.4 A	310.0abc	323.1 a	316.5 A	31.03 ab	28.83abc	29.93 C	28.90 ab	29.66 ab	29.28FG
Mean	**289.5 B***	**306.9A***		**250.2B***	**273.7A***		**27.94 B**	**28.69 A**		**29.23 B**	**30.82 A**	

Mean in each column, row or interaction with similar letter(s) are not significantly different at 5 % level.
T1 = PUT at 15 ppm, **T2 =** PUT at 30 ppm, **T3 =** SAL at 200 ppm, **T4 =** SAL at 300 ppm, **T5 =** ASC at 2000 ppm, **T6 =** ASC at 3000 ppm, **T7** = PUT at 15 ppm + SAL at 200 ppm, **T8=** PUT at 15 ppm + ASC at 2000 ppm**, T9=** SAL at 200 ppm + ASC at 2000 ppm**, T10=** PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm**.**

Concerning interaction influence, spraying trees in December with SAL at 200 ppm + ASC at 2000 ppm (T9) gave the highest values (33.33 and 37.60 ppm) in the first and second seasons, respectively.

The previous results are agree with findings of Sharma *et al.,* (2011) they reported that foliar spraying with putrescine at 50 mg/l gave the maximum of leaf potassium content on citrus rootstock Karna. Moreover, El-Badawy (2013) illustrate the highest leaf nitrogen, phosphorus and potassium leaf content was obtained with ascorbic acid at 2000 ppm on Canino apricot trees. So, on mango trees cv. "Fagri kalan", Hanan (2015) illustrate the spraying by 1Mm ascorbic acid increased leaf nitrogen, phosphorus and potassium contents in leaves. Also, Randa (2015) cleared that foliar spraying by salicylic acid at 400 ppm once or twice considerably inceased N, K and P percentages of orange leaves. These results are in agreement with Abd-El-Rhman and Attia (2016) observed that foliar spraying by salicylic acid at 1000 ppm gave the maximum of leaf mineral contents as N, K, P, Zn, Fe and Mn on olive trees. In the other hand, on Manfaloty pomegranate trees, Abd-El-Rhman *et al.,* (2017) revealed that spraying with Ascorbic acid at 2000 ppm improved leaf mineral contents as N, K, P, Mg and Ca compared with other treatments. Therefore, Abdel Aziz *et al.,* (2017) found that spraying by 100 or 200 ppm salicylic acid at three times (growth start, after fruit setting & one month later) increased leaf contents of Zn and Fe percentage on leaves of pomegranate trees.

Flowering characteristics

Data in Table (7) indicated that, number of inflorescences per meter was significantly affected by different treatments compared with control in both study seasons. In the first season application by PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm (T10) gave the highest value in this respect since it was (90.64). But in the second season application by ASC at 2000 ppm (T6) recorded the highest value (63.18) in this regard. While, the lowest values were shown with PUT at 15 ppm + SAL at 200 ppm (T7) and SAL at 200 ppm + ASC at 2000 ppm (T9) since it was (75.03 and 43.50) in both study seasons, respectively. Moreover, the time of foliar spraying shows that November application date was significantly higher value (82.12) than December (80.43) in the first season, but in the second season results showed that no significant differences between spraying dates. Concerning interaction effect, trees sprayed with SAL at 300 ppm (T4) at November recorded the highest significant value (95.56) in the first season. But, trees sprayed with ASC at 3000 ppm (T6) at November and December presented the highest values (63.04 and 63.33) in the second season, sequently.

Concerning number of total flowers per inflorescence, results in Table (7) showed that, different treatments led to significant increase in number of flowers per inflorescence in both seasons. Spraying with ASC at 3000 ppm (T6) produced the highest values (16.78 and 13.52) in the first and second seasons, severally. While, the control treatment recorded the lowest values in this regard (15.51 and 8.56) in both study seasons, respectively. As for spraying dates, December spray recorded the higher value (15.92 and 11.13) as compared with November one (15.72 and 11.04) in the first and second seasons, sequently. Regarding the interaction effect, spraying trees with ASC at 3000 ppm (T6) in December exhibited the highest numbers of total flowers per inflorescence (17.72 and 14.11) during both study seasons, respectively.

Results in the Table (7) revealed that all different treatments increased sex ratio as compared with control treatment. Tree spray with PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm (T10) and ASC at 3000 ppm (T6) presented the highest sex ratio (67.84 and 43.33%) in the first and second seasons, respectively. Meanwhile, the lowest values were under control treatment in this regard (61.04 and 38.81%) in the first and second seasons, sequently. On the other hand, in respect to the time of foliar application it observed that December spraying date was significantly higher (64.74 and 42.07%) than November one (62.62 and 40.41%) in both study seasons, consecutive. In the meantime as for interaction effect, trees sprayed with PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm (T10) in December resulted the highest value in this respect (72.52 and 45.09%) in the two studied seasons, respectively.

Flowering is the main processes influencing the productivity of fruit trees and is particularly important for olive, where biannual bearing is acutely experienced and where there is an apparently delicate relationship between vegetative and reproductive stages of growth (Lavee 2006). And particularly in 'Comice' pear, putrescine improved pollen tube ovule penetration and delayed ovule senescence without affecting flower ethylene production (Crisosto *et al.,* 1992). The obtained results

Table 7: Influence of foliar applications with putrescine, salicylic and ascorbic acid on flowering characteristics of Picual olives in 2017 and 2018 seasons.

Treat.	No. inflorescences / m						No. total flowers / infl.					
	2017			2018			2017			2018		
	Spraying date		Mean	Spraying date		Mean	Spraying date		Mean	Spraying date		Mean
	Nov.	Dec.		Nov.	Dec.		Nov.	Dec.		Nov.	Dec.	
Cont.	82.78 cde	82.52cde	82.65 BC	50.31 l	52.23 i	51.27F	15.61c-f	15.40 f	15.51 D	8.90 cd	8.22 d	8.56 J
T1	78.87 efg	77.87efg	78.37DEF	52.37 i	43.93 p	48.15H	15.51ef	15.55def	15.52 D	9.22 cd	9.61 bcd	9.41 I
T2	76.34 efg	77.99efg	77.17DEF	56.11 e	54.16 h	55.14D	15.61c-f	15.62c-f	15.62CD	11.07a-d	9.63bcd	10.35G
T3	81.13 c-f	85.96 bc	83.55 BC	48.38 n	53.94 h	51.16F	15.70c-f	15.55def	15.62CD	10.61a-d	10.41a-d	10.51F
T4	95.56 a	76.70efg	86.13 B	54.63 g	51.01 k	52.82E	15.51ef	15.64c-f	15.58 D	12.41abc	12.86abc	12.63C
T5	81.31 c-f	80.12 c-f	80.71 CD	49.29 m	51.82 j	50.56G	15.65c-f	15.62c-f	15.63CD	10.82a-d	12.41abc	11.61D
T6	73.02 g	79.70c-g	76.36 EF	63.04 a	63.33 a	63.18A	15.83b-e	17.72 a	16.78 A	12.92abc	14.11a	13.52A
T7	74.73 fg	75.33 fg	75.03 F	59.35 b	58.48 c	58.92B	15.68c-f	16.00 bc	15.84BC	9.12 cd	10.61a-d	9.86 H
T8	82.06 cde	79.08d-g	80.57CDE	46.26 o	49.42 m	47.84I	15.92bcd	15.95 bc	15.94 B	12.12a-d	9.32 bcd	10.72E
T9	85.75 bcd	79.94 c-f	82.85 BC	43.82 p	43.17 q	43.50J	15.95bc	15.88b-e	15.92 B	11.31a-d	11.91a-d	11.61D
T10	91.80 ab	89.48 ab	90.64 A	55.71 f	57.82 d	56.76C	15.88b-e	16.13 b	16.01 B	12.98abc	13.41 ab	13.19B
Mean	**82.12 A***	**80.43B***		**52.66A***	**52.67A***		**15.72 B***	**15.92A***		**11.04B***	**11.13A***	

Treat.	Sex ratio (%)					
	2017			2018		
	Spraying date		Mean	Spraying date		Mean
	Nov.	Dec.		Nov.	Dec.	
Cont.	61.04 e	61.04 e	61.04 E	39.15 hij	38.46 j	38.81 E
T1	61.87 de	61.29 de	61.48CDE	39.32 hij	38.96 ij	39.14 E
T2	61.26 de	61.46 de	61.36 DE	38.65 j	39.81 ghi	39.23 E
T3	62.63 de	62.16 de	62.40CDE	40.30 fg	39.73 ghi	40.02 D
T4	64.23 cde	63.71 de	63.97 BC	41.70 cd	41.41 cde	41.55BC
T5	62.81 de	64.60 b-e	63.71BCD	40.49 efg	41.69 cd	41.09 C
T6	62.96 de	68.16 b	65.56 AB	42.12 c	44.54 ab	43.33 A
T7	63.79 de	67.70 bc	65.75 AB	41.14 def	45.43 a	43.29 A
T8	62.81 de	64.38 b-e	63.60BCD	40.48 efg	43.72 b	42.10 B
T9	62.25 de	65.07 bcd	63.66BCD	39.92 gh	43.87 b	41.90 B
T10	63.16 de	72.52 a	67.84 A	41.19 c-f	45.09 a	43.14 A
Mean	**62.62 B***	**64.74 A***		**40.41 B***	**42.07 A***	

Mean in each column, row or interaction with similar letter(s) are not significantly different at 5 % level.

T1 = PUT at 15 ppm, **T2** = PUT at 30 ppm, **T3** = SAL at 200 ppm, **T4** = SAL at 300 ppm, **T5** = ASC at 2000 ppm, **T6** = ASC at 3000 ppm, **T7** = PUT at 15 ppm + SAL at 200 ppm, **T8**= PUT at 15 ppm + ASC at 2000 ppm, **T9**= SAL at 200 ppm + ASC at 2000 ppm, **T10**= PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm.

are in harmony with Karimi *et al.,* (2012) indicated that the highest inflorescence bud retention was obtained with foliar application of salicylic acid 250 ppm + $ZnSO_4$ 0.2% on pistachio nut trees "Owhadi cv". Additionally, on EgazyShami olive trees, Abd El-Razek *et al.,* (2013) mentioned that foliar spray of salicylic acid at 40µg/L increased flowering percentage (no. of flower buds per shoot) and flowering density (no. inflorescences per meter), as well as sex ratio percentage. On Manzanillo olive trees, Abd-El-Rhman and Attia (2016) showed that spraying by salicylic acid at 1000 ppm + potassium nitrate at 30 g/L gave the highest flowering percentage, flowering density and sex ratio compared with other treatments. In this manner, Abdul Kareem *et al.,* (2016) reported that foliar spraying with 100 ppm putrescine + 200 ppm salicylic acid gave the highest of all flowering characteristics (number of flowers per plant) on Ranunculus plant.

Final fruit set and fruit drop

Data presented in the Table (8) revealed that, final fruit set percentage was affected by conducted treatments at different spraying dates. As for tree spray with PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm (T10) gave the maximum of fruit set percentages since there were (31.54 and 24.04%) in the first and second seasons. However, the least values were under control treatment (22.27 and 15.80%) in both study seasons, respectively. As for the time of foliar application it was showed that, December application date was significantly higher values (27.47 and 20.42%) than November (25.89 and 20.02) in the first and second seasons, respectively. As for interaction effect tree spray with PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm (T10) in December recorded the highest final fruit set percentage in this respect (32.00 and 24.50%) in both study seasons, respectively.

Concerning fruit drop percentage results in the Table (8) showed that fruit drop percentage was significantly affected by different concentration treatments and spraying dates. Treated trees by PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm (T10) had the minimum fruit drop percentage (20.95 and 19.59%) in the first and second seasons, sequently. On the other hand, the treated trees by PUT at 15 ppm + ASC at 2000 ppm (T8) and PUT at 15 ppm (T1) given the maximum values (29.42 and 30.75%) in the first and second seasons, respectively. As for spraying dates results clear that, December spraying date was significantly lower values (23.47 and 22.57%) than November one (29.55 and 23.47%) in both study season, respectively. Regarding interaction effect, spraying by PUT at 30 ppm (T2) and PUT at 15 ppm + ASC at 2000 ppm (T8) in December presented the lowest fruit drop percentages (19.66 and 17.48%) in the first and second seasons, respectively. However, trees sprayed with SAL at 200 ppm + ASC at 2000 ppm (T9) at November and PUT at 15 ppm (T1) at December recorded the highest values (34.73 and 31.13%) in this respect in both study seasons, respectively.

With regarded to the effect of some growth promoters on fruit set and fruit drop, the results agree with those obtained by Omima *et al.,* (2014) indicated that foliar application with 3000 ppm ascorbic acid at full bloom, one month later & one month later after the second spray was effective in improving percentage of fruit set value of Manzanillo olive trees. However, Abd-El-Rhman and Attia (2016) found that maximum of fruit set percentage of Manzanillo olive trees verified with spraying by salicylic acid at 1000 ppm compared with the control. On the other side, On Zebda mango trees, Ali *et al.,* (2017) indicated that foliar spraying by putrescine at 0.45 mM decreased the percentage of fruit drop.

Conclusion

From the above mentioned results, generally, it could be concluded that applying putrescine, salicylic and ascorbic acid on plant the considered as an environment friend are approach to improve vegetative growth, leaves minerals content and increase flowering and final fruit set. However, it could be concluded that all spraying treatments at different concentrations and dates had a positive effect on increasing the most of parameters as compared with the control of Picual olive trees. Treatments of putrescine at 15 ppm + salicylic acid at 200 ppm + ascorbic acid at 2000 ppm (T10) were the most effective treatments to increase vegetative growth, leaves minerals content, flowering characteristics and final fruit set. Thus, these treatments can be recommended for commercial use under similar conditions.

Table 8 : Influence of foliar applications with putrescine, salicylic and ascorbic acid on final fruit set and fruit drop of Picual olives in 2017 and 2018 seasons.

Treat.	Final fruit set (%)						Fruit drop (%)					
	2017			2018			2017			2018		
	Spraying date		Mean	Spraying date		Mean	Spraying date		Mean	Spraying date		Mean
	Nov.	Dec.		Nov.	Dec.		Nov.	Dec.		Nov.	Dec.	
Cont.	20.65 h	23.88 g	22.27D	15.70 k	15.90 k	15.80 G	33.31abc	20.65 g	26.98 A	30.09a	30.02 a	30.06 AB
T1	26.50 c-g	28.70bc	27.60B	19.37 hi	19.60ghi	19.49 E	29.91a-e	25.36d-g	27.63 A	30.38a	31.13 a	30.75 A
T2	26.73 c-f	28.20cd	27.46B	20.23fgh	19.89 f-i	20.06 D	30.61a-d	19.66 g	25.14ABC	29.07ab	20.73de	24.90 C
T3	24.58 fg	25.57d-g	25.08C	18.08 j	18.08 j	18.08 F	29.88a-e	27.64b-f	28.76 A	27.84ab	28.69ab	28.26 B
T4	24.75 fg	28.24cd	26.49BC	19.10 i	20.74 ef	19.92DE	23.03efg	21.15fg	22.09 BC	26.06bc	19.89de	22.97CDE
T5	24.64 fg	27.60cde	26.12BC	20.30 fg	21.80 cd	21.05 C	30.49a-d	26.37c-g	28.44 A	20.21de	20.71de	20.46 F
T6	26.94 c-f	28.76 bc	27.86 B	22.26 c	22.20 cd	22.23 B	30.42a-d	20.85fg	25.64 AB	23.43cd	18.58 e	21.01 EF
T7	28.16 cd	25.37efg	26.77BC	20.29 fg	20.06fgh	20.18 D	28.20a-e	29.52a-e	28.86 A	25.84bc	22.80cd	24.32 CD
T8	26.12 c-g	26.13c-g	26.13BC	19.93 f-i	20.48 f	20.20 D	33.54 ab	24.94d-g	29.24 A	28.67ab	17.48 e	23.08CDE
T9	24.59 fg	27.73cde	26.16BC	21.36 de	21.42cde	21.39 C	34.73 a	21.04fg	27.89 A	25.43bc	18.62 e	22.03DEF
T10	31.08 ab	32.00 a	31.54 A	23.58 b	24.50 a	24.04 A	20.91 fg	20.98fg	20.95 C	19.52de	19.66de	19.59 F
Mean	**25.89B***	**27.47A***		**20.02B***	**20.42A***		**29.55A***	**23.47B***		**26.05A***	**22.57B***	

Mean in each column, row or interaction with similar letter(s) are not significantly different at 5 % level.
T1 = PUT at 15 ppm, **T2 =** PUT at 30 ppm, **T3 =** SAL at 200 ppm, **T4 =** SAL at 300 ppm, **T5 =** ASC at 2000 ppm, **T6 =** ASC at 3000 ppm, **T7** = PUT at 15 ppm + SAL at 200 ppm, **T8=** PUT at 15 ppm + ASC at 2000 ppm**, T9=** SAL at 200 ppm + ASC at 2000 ppm**, T10=** PUT at 15 ppm + SAL at 200 ppm + ASC at 2000 ppm.

References

Abd El-Razek E., H. S. A. Hassan and Karima M. Gamal El-Din, 2013. Effect of foliar application with salicylic acid, benzyladenine and gibberellic acid on flowering, yield and fruit quality of olive trees (*Olea europaea* L.). Middle-East J. Sci. Res., 14 (11): 1401-1406.

Abdel Aziz, F.H., M.A. El-Sayed and H.A. Aly ,2017. Response of manfalouty pomegranate trees to foliar application of salicylic acid. Assiut J. Agric. Sci., 48(2): 59-74.

Abdul Kareem, A. J., M. Saeed and R. T. Maryam, (2016).Effect of foliar spray with putrescine and salicylic acid on vegetative growth, flowering and tuberousroots qualities of ranunculus asiaticus l. Cv. 'Victoria f1' plant. Zagazig J. of Hort. Sci., 34(6A): 1953-1964.

Abd-El-Rhman I. E. and M. F. Attia ,2016. Foliar spray with potassium nitrate and salicylic acid for improving growth, yield and nutrients uptake by olive trees under salinity stress conditions. Inter. Jour. of ChemTech Rese., 9(12): 230-245.

Abd-El-Rhman, I. E., M. F. Attia, Eman S. El-Hady and Laila, F. Haggag , 2017. Effect of foliar spraying of some antioxidants and micronutrients on yield, fruit quality and leaf mineral content of manfaloty pomegranate trees (*Punica granatum* l.) Grown in a calcareous soil. Middle East J. Appl. Sci., 7(4): 713-725.

Ahmed, A.H.H, E.Darwish, and M.G. Alobaidy,2017. Impact of putrescine and 24-epibrassinolide on growth, yield and chemical constituents of cotton (Gossypium barbadense L.) plant grown under drought stress conditions. Asian J. Plant Sci., 16(1): 9-23.

Ahmed, F. F. and M. H. Morsy, 1999. A new method for measuring leaf area in different fruit species. Minia J. of Agric. & Develop. (19): 97-105.

Ahmed, F.F., A.M.K. Abdel- aal, F.H. Abdelaziz and F.M. El- Kady- Hanaa, 2011. Productive capacity of Thompson seedless grapevines as influenced by application of some antioxidants and nutrient treatments. Minia J. of Agric. Res. & Develop, 31(2): 219-232.

Ahmed, F.F., A.E.M. Mansour, M.A.A. Montasser, M.A. Merwad and E.A.M. Mostafa , 2013. Response of Valencia orange trees to foliar application of roselle, turmeric and seaweed extracts. J. Appl. Sci. Res., 9(1): 960-964.

Ali, M.S., M.A. Elhamahmy, and A.F. El-Shiekh ,2017. Mango trees productivity and quality as affected by Boron and Putrescine. Scientia Horticulturae 216: 248–255.

Brar, J.S., N.Gupta, and M.S. Gill,2014). Effect of pre and post-harvest treatments of salicylic acid on quality characteristics of peach (Prunus persica L.) fruits during storage. Progres Hortic., 46 (2), 217-221.

Brown, J. D. and D. Lilleland, 1946. Rapid determination of potassium and sodium in plant material and soil extract by flame photometer. Proc. Amer. Soc. Hort. Sci. Vol. (48): 331 - 346.

Chapman, H.D. and P.E. Pratt, 1961. Methods of Analysis for Soil, Plant and Water. Davis Agric. Sci. Pull Office Calif. Univ. 220 -308.

Crisosto, C.H., P.B. Lombard, D.G. Richardson, and R. Tetley, 1992. Putrescine extends effective pollination period in 'Comice' pear (*Pyrus communis* L.) irrespective of post-anthesis ethylene levels. Sci. Hort. 49, 211–221.

Duncan, D. B., 1955. Multiple ranges and multiple tests. Biometrics, 11: 1 - 24.

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. J. Appl. Sci. Res., 9(2): 1228-1237.

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. J. Appl. Sci. Res., 9(2): 1228-1237.

FAO, 2017. The Statistical Database (FAO STAT). Food and Agriculture Organization of the United Nations. Available in: http://faostat.fao.org [15Dec 2018]. Rome, Italy.

Fernandez, E. R. and G. V. Gomez, 1985. Cross pollination in Gordal Sevillano olives. Hortscience, 202: 191 – 192.

Franco-Mora, O., K. Tanabe, F. Tamura, and A. Itai, 2005. Effects of putrescine application on fruit set in 'Housui' Japanese pear (*Pyrus pyrifolia* Nakai). Scientia Horticulturae, 104: 265–273.

Gomez, M. L. and F. M. Lajolo, 2008. Ascorbic acid metabolism in fruits: activity of enzymes involved in synthesis and degradation during ripening in mango and guava. J. Sci. Food and Agric., 88: 756-762.

Hafez, O. M., H. A. Hamouda, and M. A. Abd El-Mageed, 2010. Effect of Calcium and Some Antioxidants treatments on Storability of Le Conte Pear Fruits and its Volatile Components. Nature and Science, 8(5): 109-126

Hanan, A. M. R. El-Hosieny,2015. Effect of ascorbic and salicylic acid on leaf area, n, p, k content as well as yield and its components of mango (*Mangifera indica* l.) Trees. J. Plant Production, Mansoura Univ., 6 (10): 1619-1629.

Jackson, M. L., 1973. Soil Chemical Analysis, Constable and Co. Ltd. Prentice Hall of India Pvt. Ltd. New Delhi. pp. 10-114.

Joseph, B., D.Jini, and S.Sujatha, 2010. Insight into the role of exogenous salicylic acid on plants grown under salt environment, Asian J. Crop Sci., 2: 226-235.

Karimi, H. R., S. Sarmadi-Far, and B. Panahi, 2012. The effect of salicylic acid and zinc on inflorescence bud abscission, leaf chlorophyll florescence and characteristic of pistachio nut cv. Owhadi. Journal of Nuts, 3(2):31-36.

Khademi, Z. and A.Ershadi, 2013. Postharvest application of salicylic acid improves storability of peach (*Prunus persica* cv Elberta) fruits. International Journal of Agriculture and Crop Science, 5, 651-655.

Khan, M. I. R., M. Fatma, T. S.Per, N.A. Anjum, N.A. Khan, 2015. Salicylic acid-induced abiotic stress tolerance and underlying mechanisms in plants. Front. Plant Sci. 6:462.

Khorshidi, M. and F.Hamedi, 2014. Effect of putrescine on lemon balm under salt stress. Int. J. Agri. Crop Sci., 7 (9):601-609.

Lavee, S., 2006. Biennial bearing in olive (*Olea ouropea*). Oea FAO Olive network, 25: 5-13.

Li, Z., Y. Zhang, D. Peng, X. Wang, Y. Peng, X. He, X. Zhang, X. Ma, L. Huang, and Y. Yanhong, 2015. Polyamine regulates tolerance to water stress in leaves of white clover associated with antioxidants defense and hydringenes via involvement in calcium messenger system and hydrogen peroxide signaling. Front Physiol., 280 (6): 16 p.

Liu, J. H., C.Honda, and T. MoraiGuchi, 2006. Involvement of polyamine in floral and fruit development. JARQ, 40 (1): 51–58.

Maksoud, M. A., Malaka A. Saleh, M. S. El-Shamma, and Amera, A. Fouad, 2009. The Beneficial Effect of Biofertilizers and Antioxidants on Olive Trees under Calcareous Soil Conditions. World J. Agric. Sci., 5(3): 350-352.

Martinez, C., E. Pons, G. Prats, and J. Leon, 2004. Salicylic acid regulates flowering time and links defense responses and reproductive development. Plant J., 37, 209-217.

Mayi, A. A., Z. R. Ibrahim, and Amira, S. Abdurrahman, 2014. Effect of foliar spray of humic acid, ascorbic acid, cultivars and their interactions on growth of olive (*Olea european* l.) Transplants cvs. Khithairy and Sorany. Jour. of Agri. and Veterinary Sci. Volume 7, Issue 4 Ver. II, PP 18-30.

Mosleh, M .S. D., J. M. A. Al-Aa'reji and G. F. H. Khalifa, 2014. Effect of sheep manure, ascorbic acid and sulphuron some growth characteristics of apricot (*Prunusn armeniaca* L.) cv. Royal. Jour. of Res. in Agri. and Ani. Scie. Volume 2 ~ Issue 8: 06-18.

Omar, A. Kh., 1999. Response of Red grapevines (*Vitis vinifera* L.) to some and biofertilizer treatments. M.Sc. Thesis. Fac. Agric. Minia Univ. Egypt.

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

Pregl, F., 1945. Quantitative Organic Micro Analysis. 4th Ed. J.A. Churchill Ltd., London.

Ragab, M. M., 2002. Effect of spraying urea, ascorbic acid and NAA on fruiting of Washington Navel orange trees. M. Sc. Thesis. Fac. Agric. Minia. Nutr., 16: 163-166.Univ. Egypt.

Randa, E. Y. Habasy, 2015. Effect of spraying salicylic acid on fruiting of Valencia orange trees. Alex. J. Agric. Res. Vol. 60, No.3, pp. 119-126.

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

Shaimaa, A. Mohamed, H.S. Ahmed and Amal, A. El-Baowab, 2018. Effect of chitosan, putrescine and irrigation levels on the drought tolerance of sour orange seedlings. Egypt. J. Hort., 45(2): 257-273.

Sharma, D. K., A. K. Dubey, M. Srivastav, A. K. Singh, R. K. Sairam, R. N. Pandey, A. Dahuja, and Ch. Kaur, 2011. Effect of putrescine and paclobutrazol on growth, physiochemical parameters, and

nutrient acquisition of salt-sensitive citrus rootstock Karna khatta (*Citrus karna* Raf.) under NaCl Stress. J. Plant Growth Regul, 30: 301–311.

Snedecor, G.W. and W.D. Cochran, 1980. Statistical methods. 7 ed. the Iowa State University Press, Ames, Iowa., U.S.A., p 491.

Talaie, A. R., M. Khezre, and A. A. Javanshah , 2010. Effect of spray application of free polyamines on prevention of some physiological problems in pistachio, "kalle-ghoochi" variety. Iranian Jour. of Hort. Sci. (41)4: 383-391.

Wettestien, V. D., 1957. Chlorophyll lethal unjjer sub mink roskpische for minvechoeljerplastijen. Exp. Cell Res., 12: 427 - 433.

Wild, S. A., R. B. Corey, J. G. Lyer, and G. K. Voigt, 1985. Soil and Plant Analysis for Tree Culture. Oxford and IBH Publishing Co., New Delhi, India.