ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Influence of Spraying Kalmata and Picual Olive Trees with GA_3 and $ZnSO_4$ on Leaf Nutrient Status and Chlorophyll Content

Desouky IM[1]*, Shaltout AD[1], Laila F Haggag [2], Amira A Fouad [2] and Esraa MM Farahat [2]

[1]Hortic. Dept. Fac. Agric., Ain Shams Univ., Shoubra El-Kheima, Cairo, Egypt.
[2]Pomology. Dept. National Research Centre, El-Tharir Str., Dokki, Egypt.

ABSTRACT

This work was performed to study the effect of spraying Kalamata &Picual olive trees with Zn sulfate (0.0, 0.5 and 1.0 %) and GA3 at (0, 20 and 40 ppm) on some leaf nutrient and chlorophyll content. Data reveal that applying zinc sulfate at the two tested concentration 0.5 &1.0 % enhanced the leaf N, K, Mg, Fe Zn and Mn content of the two olives, cultivars while the leaf P content was not affected. Moreover, the GA3 at 20 and 40 ppm sprays tended to increase the leaf N, K, Zn content of the two cultivars and this increase reached the significant level in some cases. Treatments seemed to have a very limit effect in leaf P percentage. On the other hand, the leaf Fe, Mn and chlorophyll content differed from cultivar to other. In this respect, the GA3 sprays (20 &40 ppm) significantly increased the values of leaf Fe, Mn & chlorophyll on the Kalamata cultivar than that of the control an opposite result was noticed in the Picual one .Leaves from Kalamata trees receive the GA_3 at 40 ppm coupled with Zinc sulfate at 1 % showed the higher leaf mineral content, whereas leaves of trees received zinc sulfate at 0.5% either alone or coupled with 20 ppm GA3 showed the highest values of chlorophyll a & b. On the other hand, leaves of Picual trees sprayed with zinc sulfate at 1% exhibited the higher percentage of most studied nutrient and chlorophyll content.

Keywords: Olive (Olea europaea), Kalamata, Picual, GA_3, $ZnSO_4$, Leaf nutrient status and chlorophyll content

*Corresponding author

INTRODUCTION

The olive tree (Olea europaea L.) has been cultivated for approximately 6000 years in Mediterranean countries where about 95% olive resources are located. Its habitat is determined by the Mediterranean climate, which is characterized by relatively mild winters and hot, dry summers. The proverbial adaptation of the olive tree to the Mediterranean climate is the reason why it is basically a dry formed crop **(I.O.O.C. 2000)**.

According to statistical of Food and Agriculture Organization **(FAO, 2013)**, the world area cultivated with olive trees in 2013 is about 4,268,415 feddans and world production of olive is 20,344,343 tons.

The Egyptian olive production cultivation was about 563,070tons produced from acreage 202,743 feddan, most of which are processed mainly as table olive and the rest is extracted to olive oil, **(Ministry of Agriculture and Land Reclamation, 2013).** Gibberellins are plant growth regulators that involved in many growth and development processes. GA_3 increased plant size as a result of increased photosynthetic rates or due to more efficient utilization of photosynthetic products**.** GA_3 are known for their capability to increase cell enlargement (**Arteca, 1996 and Davis 2004).**

The foliar application of GA_3 on plum tree significantly increased the leaf N% and K% content while leaf P% content was insignificant **Hassan,** *et al.* **(2010**). **And also Eman,** *et al***. (2011),** showed that the leaf N, P and Fe content were general, improved by increasing the concentration of GA_3 as compared with control. While, leaf K, Mn and Zn were not significant affected. Furthermore, **Al-Aa'reji and Al-Hamadany (2006)** noticed that treated olive transplants with GA_3 led to a significant increase in the amount of total chlorophyll. On the other hand, **Hoda, et al. (2010)** showed that, reduction of chlorophylls (a) and (b) as a result of foliar spray of gibberellins GA3 on leaves of citrus rootstock seedlings.

Zinc is one of the necessary micronutrients for plant growth. Zinc plays a role in the synthesis of tryptophan, which is a source of IAA. Zinc is a cofactor for more than 300 enzymes, proteins and has a specific effect on cell division, protein synthesis and nucleic acid metabolism**,** photosynthesis reaction and carbohydrate biosynthesis which due to increased of leaf mineral content **Omaima,** *et al***.(2007), also** Zn is a part of carbonic anhydrous enzyme, present in all photosynthetic tissues and it is required for chlorophyll biosynthesis **(Ryugo, 1988**).

The micronutrients foliar application enhanced leaf nutrients status and corrected some fertilizer deficiency. The foliar application significantly increased the leaf Zn content **Sahota and Arora (1981), Omaima,** *et al***.(2007**); **Erdem and Ozturk (2012) and Razzaq***, et al***. (2013),** on citrus; **Nezami, (2012),** on almond; **Reid and Thomas (2013),** on black walnut and **Soliemazadeh,** *et al***.(2013**). In addition**,** spraying Zn significantly increased the **l**eaf N, P, K content **Omaima,** *et al***.(2007**) and **Razzaq***, et al***. (2013)** on citrus. Furthermore, **Sayyad-Aminand and Shahsavar(2012), Jasrotia,A.,***et al***. (2014**), on olive they found that the foliar application of zinc had significantly increased on leaf chlorophyll content.

This study was conducted to study the effect of spraying Kalamata and Picual olive trees with GA_3 and $ZnSO_4$ on leaf mineral content and chlorophyll contents.

MATERIALS AND METHODS

This study was carried out during two successive seasons, (2012, 2013) in a private orchard located at Ismailia Governorate, Egypt. The study was conducted on forty -five mature trees of the tow olive cultivars (Kalamata and Picual). The trees were about 8 years old, grown in a sandy soil at five meters apart under drip irrigation system The trees were almost similar in vigor, free from any visible pathogenic symptoms and at the same bearing phase. Trees received the ordinary agricultural practices.

Selected trees were divided into nine similar groups each of five trees; each group received one of the following treatments:

1- Control (water spray). .
2- GA_3 at 0 ppm + $ZnSO_4$ at 0.5%.
3- GA_3 at 0 ppm + $ZnSO_4$ at 1 %.

4- GA$_3$ at 20 ppm + ZnSO4 at 0.0 %.
5- GA$_3$ at 20 ppm + $ZnSO_4$ at 0.5%.
6- GA$_3$ at 20 ppm + $ZnSO_4$ at 1 %.
7- GA$_3$ at 40 ppm + $ZnSO_4$ at 0.0 %.
8- GA$_3$ at 40 ppm + $ZnSO_4$ at 0.5%.
9- GA$_3$ at 40 ppm + $ZnSO_4$ at 1%.

Therefore, each treatment was replicated five times and each replicate consisted of one tree. Sprays were applied when fruits reached about two third of their commercial volume. Each tree was sprayed alone with the aqueous nutrient solution which was enough for thorough tree drenching (1% soluble soap was added as a wetting substance).

The measurements:

For each experimental tree, a leaf sample from the middle portion of ten shoots of the spring flush (not fruiting and not flushing) was randomly collected at mid-September of each season. Collected leaves were mixed together and random sample of fifteen leaves was chosen.

1-1- Leaf mineral content

Leaf samples were washed and dried at electric oven at 70 0 c till constant weight, and then grounded for determination the following nutrient elements (in dry weight basis)

a. **Nitrogen (N): U**sing the modified micro – kjeldahl method as lined by **Pregl, (1945)**.
b. **Phosphorus (P):** Using stannous chloride- sulfuric acid method according to **Chapman and Pratt, (1961).**
c. **Potassium (K**): Using the flame photometric method according to **Brown and Lilleland, (1946).**
d. **Magnesium (Mg)**: Using Atomic Absorption according to **Jackson, (1973).**
e. **Iron (Fe), Zinc (Zn) and Manganese (Mg)**: Were determined as PPM using Atomic Absorption according to **Jackson, (1973).**

1-2- Pigments

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

Statistical analyses:

The data 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 the probability of 5%.

RESULTS AND DISCUSSIONS

Effect of spraying Kalamata and Picual olive trees with GA3 and $ZnSO_4$:-

1- Leaf mineral content

Data in Table (1, 2) show the effect of spraying Kalamata and Picual olive trees with an aqueous solution containing GA3 and/or ZnSO4 nutrient on leaf mineral content.

1-1 Nitrogen (%)

The data in Table (1) showed that, the leaf N (%) for Kalamata cultivar was significantly affected by spraying GA3 at (40 ppm) compared with spraying GA3 at (20 ppm) and control, while in Picual cultivar the leaf N (%) was significantly affected by spraying GA3 at both concentrations (20 and 40 ppm).

As for ZnSO4, It could be seen that the leaf content of N in both cultivars was significantly affected by spraying ZnSO4 at the two tested concentrations (0.5 and 1 %) and spraying ZnSO4 at high concentration (1%) was more effective than the lower one (0.5%).

Concerning the interaction, it could be noticed that the highest leaf N (%) for Kalamata cultivar was obtained from trees sprayed with (40 ppm GA3+1% ZnSO4) about (21% over the control), while treated Picual trees with ZnSO4 at 1% either alone or coupled with GA3 at 20 ppm resulted in about (27 and 25%) increase in the leaf K% than the control for the two treatments respectively.

The results of spraying GA3 in line with that observed by Eman and waffa (2006), on sultani fig trees, they found that leaf N content was increased as the result of spraying with GA3 and also, Hassan, et al. (2010), on plum trees who noticed that leaf N% content was significantly increased as the results of spraying with GA3 (20 ppm) in addition to, Eman and waffa (2011), on sultan fig who found that N content was general, improved by increasing the concentration of GA3 as compared with control

The obtained results of spraying ZnSO4 are in harmony with that reported by Omaima, et al.(2007) and Razzaq, et al. (2013) on citrus they found that leaf N content significantly increased with foliar application of Zn.

1-2 Phosphorus (%)

Data in Table (1) indicated the effect of spraying Kalamata and Picual olive trees with GA3 and ZnSO4 on the leaf P content.

It could be seen that the leaf P % was not affected by spraying GA3 or/ and ZnSO4. This effect was true in both seasons.

The obtained results of spraying GA3 are in line with that reported by Hassan, et al. (2010), who noticed that leaf P% content was insignificant as the results of spraying with GA3 (20 ppm) when compared with control and Hoda, et al.(2010) on citrus, who noticed the effect of GA3 did not show any affected on leaf P.

The results of spraying ZnSO4 are in agreement with that obtained by (Sahota and Arora 1981, Erdem and Ozturk (2012), on citrus; Taheri and Talaie (2001), Jasrotia,A.,et al. (2014) on Olive who noticed that the leaf P was not affected by spraying Zn.

1-3 Potassium (%)

Data given in Table (1) revealed that, for kalamata cultivar, the two GA3 concentrations caused a significant improved in the leaf K (%) when compared with the control, while the leaf K (%) from Picual trees was slightly improved by spraying 20 ppm GA3, while spraying 40 ppm GA3 gave a significant increased in the leaf K(%) comparing with control.

As for ZnSO4, it could be observed that there were significantly increased in leaf content of K for Kalamata cultivar when spraying with ZnSO4 at both concentrations. While the only significant difference in the K content in the leaf of Picual was noticed when the high ZnSO4 concentration (1%) was applied.

With respect to the interaction, it could be noticed that the leaf from Kalamata trees received (GA3 at 40 ppm+ 1% ZnSO4) gave the highest K % which about (45% over the control), while spraying Picual trees with ZnSO4 at 1% either alone or coupled with 0.5% GA3 gave the highest leaf K (%), this increase reached about (16 and 17%) over the control for the two treatments, respectively.

The results of spraying GA3 in line with that observed by Hassan, et al. (2010), on plum trees who noticed that leaf K content was significantly increased as the results of spraying with GA3 (20 ppm) and Hoda, et al. (2010) on citrus who noticed that leaf K content was increasing as a result for spray of GA3.

The obtained results of spraying ZnSO4 are in harmony with that reported by Omaima, et al. (2007) and Razzaq, et al. (2013), on citrus and also. Jasrotia, et al. (2014) on olive who found that the K leaf was increased by spraying ZnSO4.

1-4 Magnesium (%)

The data in Table (1) investigated that the leaf Mg content was not affected by spraying 20ppm GA3, meanwhile, it was significantly decreased by spraying GA3 at 40 ppm compared with control. This affect was true in both cultivars.

As for ZnSO4, it could be noticed that for Kalamata cultivar, the only significantly increase in leaf Mg% was observed by spraying ZnSO4 at 0.5% compared to control and 1% ZnSO4. Meanwhile spraying Picual olive trees with ZnSO4 (0.5 and 1%) increased the leaf Mg concentration and this increase was significantly when spraying with ZnSO4 at 1%.

Concerning the interaction, it could be seen that spraying Kalamata olive trees with ZnSO4 at (0.5%) either alone or coupled with 20 ppm GA3 gave the highest leaf Mg%, while applying Picual olive trees with ZnSO4 at 1% alone gave the highest leaf content of Mg.

The obtained results of spraying Kalamata olive trees are in harmony with that observed by Nezami, (2012), on almond obtained that the foliar application of zinc had no effect on Mg.

The obtained results of spraying Picual olive trees with ZnSO4 are in line with that found by Jasrotia,A.,et al. (2014) on olive , who found that leaf magnesium was significantly increased by spraying ZnSO4.

1-5 Iron (ppm):

Data in Table (2) revealed that, treated Kalamata olive trees with GA3 At (40 ppm) caused a significantly increased in the leaf content of Fe compared with spraying 20 ppm GA3 and control, furthermore for Picual cultivar the leaf content of (Fe) was significantly decreased by spraying GA3.

Concerning the effect of ZnSO4, it could be seen that the leaf content of (Fe) in both cultivars was significantly affected by spraying ZnSO4 either at 0.5% or 1%.

Concerning interaction between spraying GA3 and ZnSO4, data showed that applying Kalamata olives with GA3 at 40 ppm coupled with ZnSO4 either at 0.5 or 1% resulted in (13 and 11%) increase in leaf (Fe) content than the control for the two treatments, respectively. Moreover, in the Picual cultivar, spraying ZnSO4 at 1% alone gave the highest value (about 18%).

The obtained results of spraying Kalamata olive trees with GA3 are in agreement with that obtained by Eman and waffa (2006) and Eman and waffa (2011) on sultani fig trees who found that the concentration of Fe was increased by spraying GA3. While the obtained results of spraying Picual olive trees with GA3 are in harmony with that obtained by Hoda, et al. (2010), on citrus who found that the Fe content of leaves was decreased by increasing GA3.

The results of spraying ZnSO4 are in line with that observed by Razzaq, et al. (2013), they reported that the foliar application of Zn affected significantly on the leaf Fe.

1-6 Zinc (ppm)

As shown in Table (2) the leaf content of Zn for both cultivars was significantly affected by spraying 40 ppm GA3 compared with those of spraying 20 ppm GA3 and control. Concerning the effect of Zn, it could be noticed that spraying ZnSO4 at (0.5 and 1%) caused a significantly increased in the concentration of Zn in the leaf of both cultivars other than control and ZnSO4 sprayed at high concentration (1%) was more effective than the lower one (0.5 %).

The data of the interaction, it could be seen that the highest leaf concentration of Zn of Kalamata cultivar was obtained from trees sprayed with 40 ppm GA3 coupled with ZnSO4 at 1%, while treated Picual trees with GA3 at 40 ppm coupled with ZnSO4 at 0.5 % gave the highest leaf Zn content.

The obtained results of spraying GA3 are in line with that reported by Eman and waffa (2006), on sultani fig trees who found that the concentration of Zn was increased by spraying GA3

The result of the effect of ZnSO4 in increasing the leaf concentration of ZnSO4 are in line with that observed by Sahota and Arora (1981), Omaima, et al.(2007); Erdem and Ozturk (2012) and Razzaq, et al. (2013), on citrus; Nezami, (2012), on almond; Reid and Thomas (2013), on black walnut and Soliemazadeh, et al.(2013), on pistachio they noticed that the foliar application of Zn significantly increased the leaf zinc levels.

1-7 Manganese (ppm):

Data in Table (2) indicated that, in Kalamata cultivar, the leaf content of (Mn) was slightly improved by spraying 20 ppm GA3, while spraying 40 ppm GA3 gave a significant increased in the (Mn) concentration comparing with control. As for Picual cultivar, it could be noticed that the leaf concentration of (Mn) was significantly decreased by spraying GA3.

Concerning the effect of ZnSO4, for Kalamata cultivar It could be seen that there were no significant differences in the leaf content of (Mn) between spraying ZnSO4 at (0.5 and 1%) and control, while spraying ZnSO4 at 0.5% significantly improved the concentration of (Mn) compared with applying 1% ZnSO4. As for Picual cultivar, the leaf (Mn) content was affected significantly by spraying ZnSO4.

The interaction, it could be observed that treated Kalamata olive trees with (GA3 at 20 ppm coupled with 0.5% ZnSO4 gave the highest content, meanwhile applying ZnSO4 at (1%) alone gave the highest leaf Mn content for Picual cultivar.

The obtained results of spraying Kalamata olive trees with GA3 are in line with that reported by Eman and waffa (2006), on sultani fig trees who found that the concentration of Mn was increased by spraying GA3. While the obtained results of spraying Picual with GA3 are in harmony with Hoda, et al. (2010), on citrus who found that the Mn content of leaves was decreased by spraying GA3.

The results of spraying ZnSO4 in Kalamata cultivar are in line with that observed by Nezami, (2012), on almond who obtained that the foliar application of zinc had no effect on Mg and also Razzaq, et al. (2013), who studied the effects of foliar applications of zinc sulfate at (0., 0.2, 0.4, 0.6 and 0.8%) at the fruit set stage on tree 'Kinnow' mandarin nutrition and found that the highest manganese (Mn) were observed for trees sprayed with 0.2% zinc sulfate

The results of spraying ZnSO4 in Picual cultivar are agreement with that obtained by Razzaq, et al. (2013), who found that the foliar application of Zn significantly increased the leaf concentration of Mn

Table (1): Effect spraying Kalamata and Picual olive trees with GA_3 and $ZnSO_4$ on leaf N, P, K and Mg contents during 2012&2013 seasons (combined analysis).

	Kalamata				Picual			
$ZnSO_4$ / GA_3	0%	0.5%	1%	Mean	0%	0.5%	1%	Mean
	N (%)							
0 ppm	1.58 c	1.79 ab	1.75 b	**1.71 B**	1.57d	1.72 cd	2.00 a	**1.76 B**
20 ppm	1.73 b	1.73 b	1.80 ab	**1.75 B**	1.74 cd	1.82 bc	1.96 a	**1.84A**
40 ppm	1.79 ab	1.83 ab	1.91 a	**1.84 A**	1.84 bc	1.88 ab	1.83 bc	**1.85 A**
Mean	**1.70 B**	**1.78AB**	**1.82 A**		**1.72 C**	**1.81 B**	**1.93 A**	

	P (%)							
0 ppm	0.14a	0.15 a	0.16 a	**0.15 A**	0.18 a	0.19 a	0.22 a	**0.20 A**
20 ppm	0.16 a	0.15 a	0.17 a	**0.16 A**	0.19 a	0.20 a	0.23 a	**0.21 A**
40 ppm	0.15 a	0.17 a	0.16 a	**0.16 A**	0.18 a	0.19 a	0.20 a	**0.19 A**
Mean	**0.15 A**	**0.16 A**	**0.16 A**		**0.18 A**	**0.19 A**	**0.22 A**	
	K (%)							
0 ppm	0.64 c	0.75 bc	0.69 bc	**0.69 C**	0.81 c	0.87abc	0.94 a	**0.87 B**
20 ppm	0.74 bc	0.84 ab	0.81 ab	**0.80 B**	0.85 bc	0.89 ab	0.95 a	**0.90 AB**
40 ppm	0.83 ab	0.79 ab	0.93 a	**0.85 A**	0.91 ab	0.92 ab	0.91 ab	**0.91 A**
Mean	**0.74 B**	**0.79 A**	**0.81 A**		**0.86 B**	**0.89 B**	**0.93 A**	
	Mg (%)							
0 ppm	0.22 c	0.34 a	0.27 b	**0.28 A**	0.12 b	0.20 ab	0.25 a	**0.19A**
20 ppm	0.27 b	0.30 ab	0.25 bc	**0.27 AB**	0.16 ab	0.18 ab	0.17 ab	**0.17 A**
40 ppm	0.27 b	0.22 c	0.24 bc	**0.24 B**	0.15 ab	0.12 b	0.11 b	**0.13 B**
Mean	**0.25 B**	**0.29 A**	**0.25 B**		**0.14 B**	**0.17AB**	**0.18 A**	

Means having the same letters within a column are not significantly different at 5% level.

Table (2): Effect of spraying Kalamata and Picual trees with GA_3 and $ZnSO_4$ on leaf Fe, Zn and Mn content during 2012&2013 seasons (combined analysis).

	Kalamata				Picual			
$ZnSO_4$ / GA_3	**0%**	**0.5%**	**1%**	**Mean**	**0%**	**0.5%**	**1%**	**Mean**
	Fe (ppm)							
0 ppm	326.3 bc	317.6 bc	337.2 b	**327.0B**	309.0 c	350.0 b	365.4 a	**341.5A**
20 ppm	314.6 c	363.1 ab	318.8 bc	**332.2B**	286.4 d	346.1 b	350.2 b	**327.5B**
40 ppm	321.0bc	369.67 a	364.0 ab	**351.6 A**	292.0 d	295.0 d	308.2 c	**298.4 C**
Mean	**320.6 B**	**350.1 A**	**340.0 A**		**295.8 B**	**330.4 A**	**341.3A**	
	Zn (ppm)							
0 ppm	23.24f	59.09 d	72.96a	**51.76B**	26.41 f	57.29 d	69.41 b	**51.04 B**
20 ppm	21.58f	63.17 c	68.56b	**51.10 B**	21.96 g	61.96c	70.81 ab	**51.58B**
40 ppm	45.49e	66.37 b	74.44a	**62.10 A**	44.27 e	72.07 a	67.20b	**61.18A**
Mean	**30.10 C**	**62.88 B**	**71.99A**		**30.88 C**	**63.77 B**	**69.14 A**	
	Mn (ppm)							
0 ppm	46.55 b	47.20 ab	46.79 ab	**46.85 B**	37.41 cd	37.22 cd	45.83 a	**40.15 A**
20 ppm	47.20 ab	51.08 a	45.55 b	**47.94 AB**	35.87de	38.80 c	37.65 cd	**37.44 B**
40 ppm	49.86 ab	49.84 ab	49.16 ab	**49.62 A**	34.47 e	39.3 c	41.65 b	**38.47 B**
Mean	**47.87 AB**	**49.37 A**	**47.17 B**		**35.92 C**	**38.44 B**	**41.71A**	

Means having the same letters within a column are not significantly different at 5% level.

2- Leaf chlorophyll content

Data in Table (3) indicated that the leaf chlorophyll (A& B) contents of Kalamata cultivar was significantly affected by spraying 20 ppm GA3 compared with those of spraying 40 ppm GA3 and control, while in Picual cultivar the leaf chlorophyll (A) content was significantly decreased by spraying GA3 either at 20 or 40 ppm, meanwhile, chlorophyll B was significantly decreased by spraying GA3 at 40 ppm compared with control and 20 ppm GA3

As for ZnSO4, it could be noticed that the only significant increased in the leaf chlorophyll (A& B) content of Kalamata cultivar were noticed when the low ZnSO4 concentration (0.5%) was applied. Furthermore, spraying Picual olive trees with ZnSO4 (0.5 and 1%) seemed to have a significant increased on the leaf chlorophyll content.

Concerning the interaction, for Kalamata cultivar the highest leaf chlorophyll (A& B) content was observed from trees sprayed with ZnSO4 0.5% either alone or coupled with 20 ppm GA3. As for Picual cultivar the highest leaf chlorophyll (A& B) content was observed from trees sprayed with ZnSO4 at 1% alone.

The obtained results of spraying Kalamata olive trees with GA3 are in agreement with that obtained by Al-Aa'reji and Al-Hamadany (2006) noticed that treated olive transplants with four concentrations of GA3 (0, 50, 100 and 150 ppm GA3) led to a significant increase in the amount of total chlorophyll. And also, Al-Hmadawi, et al. (2011), found that spraying fig cv. Aswod Diala with GA3 (200 ppm) produced a significant increase in total chlorophyll. The reason of that wasGA3 acts to accumulate nutrition elements from plant parts to positions which GA3 accumulated. As well as, Moneruzzaman, et al. (2011), suggests that chlorophyll synthesis was enhanced by spraying GA3 at lower concentrations and higher concentration showed a negative effect on chlorophyll synthesis when Wax apple trees treated with GA3 at (20.50.100) ppm. Furthermore, Mayi, et al. (2013) treated two olive cultivars (Kithary and Sorany) with GA3 at (0, 250, 500 and 750) ppm and noted that the transplant when treated GA3 at 500 ppm gave the highest chlorophyll content value and the lowest value recorded in untreated transplant.

The results of the effect of spraying Picual olive trees with GA3 are in line with Hoda, et al. (2010) they found a reduction of chlorophylls (a) and (b) as a result of foliar spray of GA3 on leaves of citrus rootstock seedlings. These results also are in harmony with those obtained by (Monselise and Halevy 1962) who reported that chlorophyll content was decreased when sweat lime seedlings treated by GA3. Moreover, (Monge, et al., 1994), they studied the effect of spray of 1000 ppm GA3 on adult peach trees {Prunus persica (L.) Batsch} and found that GA3 significantly reduced the concentrations of chlorophylls (a, b).

The results of spraying ZnSO4 are harmony with that observed by Sayyad-Amin and Shahsavar (2012) and Jasrotia, et al. (2014), on olive, they reported that the foliar application of Zn significantly increased the chlorophyll content.

Table (3): Effect of spraying Kalamata and Picual olive trees with GA_3 and $ZnSO_4$ on leaf chlorophyll content during 2012&2013 seasons (combined analysis).

	Kalamata				Picual			
$ZnSO_4$ / GA_3	0%	0.5%	1%	Mean	0%	0.5%	1%	Mean
	Chlorophyll (A) (mg.g $^{-1}$)							
0 ppm	0.63 c	0.91 a	0.67 c	**0.74 B**	0.56 c	0.80 b	1.06 a	**0.81 A**
20 ppm	0.82b	0.95 a	0.75b	**0.84 A**	0.75 b	0.76 b	0.77 b	**0.76 B**
40 ppm	0.75b	0.77 b	0.62 c	**0.71 B**	0.74 b	0.62 c	0.55 c	**0.64 C**
Mean	**0.73B**	**0.88A**	**0.68B**		**0.68 C**	**0.73 B**	**0.79 A**	
	Chlorophyll (B) (mg.g $^{-1}$)							
0 ppm	0.22d	0.38 a	0.28 c	**0.29 B**	0.22 bc	0.35 ab	0.42 a	**0.33 A**
20 ppm	0.36ab	0.38 a	0.29 c	**0.34 A**	0.32 b	0.31 b	0.34 ab	**0.32 A**
40 ppm	0.30 c	0.34 b	0.26cd	**0.30 B**	0.28 bc	0.22 bc	0.20 c	**0.23 B**
Mean	**0.29 B**	**0.37A**	**0.28 B**		**0.27 B**	**0.29 AB**	**0.32 A**	

Means having the same letters within a column are not significantly different at 5% level.

REFERENCES

[1] Al- Hmadawi, M. S. A.; M. H. R. Al – Numani and H. M. W. AL – Shemmery (2011): Effect of pruning and spraying with N, Ca and GA3 on some characters of fruits and percentage of cracking of fig cv. Asowd Diala. Euphrates journal of agriculture science researches of the first international conference (Babylon and Razi Universities), 52- 62.

[2] Al-Aařeji, J. M. A. and Al-Hamadany, M. H. S. (2006): Effect of foliar application of Iron and gibberellic acid on some vegetative growth parameters of three cultivars of olive transplants. Journal Kerbela University.

[3] Arteca, R. N. (1996). Plant Growth Substances: Principles and Applications. Chapman and Hall Press, New York, USA, p. 332.

[4] Brown, J. D. and Lilleland, D. (1946). Rapid determination of potassium and sodium in plant material and soil extract by flame photometer. Proc. Amer. Soc. Hort. Sci.

[5] Chapman, H.D. and Pratt, P.E. (1961). Methods of Analysis for Soil, Plant and Water. Davis Agric. Sci. Pull Office Calif. Univ. 220 -308. Vol. (48) : 331 - 346.

[6] Davis, P.J. (2004). The plant hormones: their nature, occurrence and functions. In: Davis, P.J. (Ed.), Plant Hormones. Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 1-1.

[7] Duncan, D. B. (1955). Multiple ranges and multiple tests. Biometrics, 11: 1 - 24.

[8] Eman, E. K. Abd-Ella and Wafaa, A. A. Z. El-sisi, (2006): Effect of foliar application of gibberellic acid and micronutrients on leaf mineral content, fruit set, yield and fruit quality of Sultani fig trees. Journal of Advances in Agricultural Research, 11(3):567-578.

[9] Eman, E. K. Abd-Ella and Wafaa, A. A. Z. El-sisi, (2011): Effect of foliar application of some growth promotres on growth, fruiting and fruit quality of Sultani fig trees. J.Agric.&Env.Sci.Alex.Univ.,Egypt. 10(2):1- 25.

[10] Erdem, H. and B. Öztürk, (2012): Effect of foliar applied zinc on yield, mineral element contents and biochemical properties of Pear varieties gafted to BA-29 rootstock. Ziraat Fakültesi Dergisi - Süleyman Demirel Üniversitesi, 7 (1):93-106.

[11] FAO (2013): The Statistical Database (FAOSTAT). Rome, Italy: Food and Agriculture Organization of the United Nations. Available in: http://faostat.fao.org.

[12] Hassan, H. S. A.; S. M. A. Sarrwy and E. A. M. Mostafa (2010): Effect of foliar spraying with liquid organic fertilizer, some micronutrients and gibberellins on leaf mineral content, fruit set, yield and fruit quality of "Hollywood" plum trees. Agric. Biol. J. N. Am. 1(4): 638-643.

[13] Hoda, M. Mohamed; G.F. Abd El-Rahman and M. E. Abd El-Raheem (2010): Impact of gibberellic acid enhancing treatments on shortening time to budding of citrus nursery stocks. Journal of American Science, 6(12) : 410-422.

[14] International Olive Oil Council (2000). World Catalogue of olive Varieties.

[15] Jackson, M.L. (1973). Soil Chemical Analysis. Prentice – Hall, Inc., India.

[16] Jasrotia, A. ; P. Bakshi; K. V. Wali; B. Bhushan and D. J. Bhat (2014):Influence of girdling and zinc and boron application on growth ,quality and leaf nutrient status of olive cv. Frontoio. African Journal of Agricultural Research, 9(18): 1354-1361

[17] Ministry of Agriculture and Land Reclamation (2012): Agricultural statistics, V(2):276.

[18] Mayi, A. A.; A. S. Abdulrhman and Z. R. Ibrahim (2013): Effect of foliar spray of Fe, GA3, cultivars and their interactions on growth of olive (Olea europaea L.) transplants cvs. Khithairy and Sorany. Journal of Agricultural Science and Technology B 3: 358-368.

[19] Moneruzzaman, K. M.; A. B. M. S. Hossain; O. Normaniza and A. N. Boyce (2011): Growth, yield and quality responses to gibberellic acid (GA3) of Wax apple Syzygium samarangense var. Jambu air madu fruits grown under field conditions. Afr. J. Biotechnol. 10(56):11911-11918.

[20] Monge, E.; R. Aguirre and E.E. Blanco (1994): Application of paclobutrazol and GA3 to adult peach trees: Effects on nutritional status and photosynthetic pigments. J. Plant Growth. Reg. 13 (1), 15-19.

[21] Monselise,S.P and A.H. Halevy (1962): Effect of gibberelline and AMO. 1618 on growth, drymatter accumulation, chlorophyll content and peroxidase activity of citrus seedlings. Amer. J. Bot.49:405-412.

[22] Nezami, M. T. (2012): The effects of foliar applications of nitrogen, boron, and zinc on the fruit setting and the quality of Almonds. Life Science Journal, 9(4) **:**1979- 1989.

[23] Omaima, H. M. and I. M. El-Metwally (2007): Efficiency of zinc and potassium sprays alone or in combination with some weed control treatments on weeds growth, yield and fruit quality of Washington navel orange orchards. Journal of Applied Sciences Research, 3(7): 613-621.

[24] Pregl, F. (1945). Quantitative Organic Micro Analysis. 4 th Ed. J.A. Churchill Ltd., London.

[25] Razzaq, K.; A. S. Khan; A. U. Malik; M. Shahid and S. Ullah (2013): Foliar application of zinc influences the leaf mineral status, vegetative and reproductive growth, yield and fruit quality of 'Kinnow' Mandarin. Journal of Plant Nutrition, 36:1479–1495.

[26] Reid, W. R. and A.L. Thomas (2013): Influence of foliar fertilization on foliar zinc levels and nut production in black walnut. Proceedings of the 7th Walnut Council Research Symposium pp: 101- 105

[27] Ryugo, K. (1988). Fruit culture: It's Science and Art. John Wiley and Sons 29-261.

[28] Sahota, G. S. and J. S. Arora, (1981): Effect of N and Zn on `Hamlin' sweet (Citrus sinensis Osbeck) . J. Japan.Soc. Hort. Sci. 50(3): 281-286.

[29] Sayyad-Amin, P. and A. R. Shahsavar (2012): The influence of urea, boric acid and zinc sulphate on vegetative traits of olive. J. Biol. Environ. Sci., 6(16): 109-113.

[30] Snedecor, G. A. and W. G. Cochran, (1980): Statistical Methods. Oxford and J. B. H. Bub Com. 7th Edition.

[31] Soliemazadeh, A.; V. Mozafari; A. T. POUR and A. Akhgar, (2013): Effect of Zn, Cu and Fe foliar application on fruit set and some quality and quantity characteristics of Pistachio trees. Journal of Horticulture Biology and Environment, 4 (1): 19-3.

[32] Taheri, M. and A. Talaie (2001): The effects of Chemical spray on the qualitative and quantitative characteristics of "Zard" olive fruits. Acta Hort. 564: 337- 341.

[33] Wettestien, V. D. (1957). Chlorophyll lethal unjjer sub mink rosk pische for minvechoel jer plastijen. Exp. Cell Res. 12: 427 - 433.