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Influence of Spraying Kalamata and Picual Olive Trees with GA_3 and $ZnSO_4$ on Productivity and some Fruit Properties

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Abstract : This work was performed to study the effect of spraying Kalamata and Picual olive trees with the aqueous solution of GA_3 at (0.0, 20 and 40 ppm) or $ZnSO_4$ at (0.0, 0.5 and 1%) and their companions on trees productivity and fruit properties. Treatments were applied when fruits reached about two third of their commercial volume, the (beginning of final swelling stage). Data obtained revealed that values of average yield as (kg/ tree) for Kalamata olive trees received GA_3 at 40 ppm alone surpassed those of the other tested treatments. Also, values of average fruit weight (g) and volume (cm3), flesh/ stone ratio and dry oil percent were enhanced due to these two treatments (GA_3 at 40 ppm alone or coupled with $ZnSO_4$ at 0.5%). As for the Picual trees, the maximum increase in yield and flesh oil percentage resulted from applying GA_3 at 40 ppm alone. The highest values of fruit weight and volume and flesh /stone ratio were obtained in trees sprayed with GA3 at 40 ppm coupled with ZnSO4 at 1%.
Kew words: Olive (*Olea europaea* L.), Kalamata, Picual, GA_3, $ZnSO_4$, yield, fruit weight, fruit volume, flesh/ stone ratio, oil content.

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 characterised 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[1].

According to[2] the cultivated area of olive in the world reached about 4,268,415 feddans producing about 20,344,343 tons about 90% of which is channelled into oil production while the remaining 10% is for table olives.

Olives are considered among the major commercial fruit varieties grown in Egypt its ranks the fourth after citrus, mango and grapes

Gibberellins have the capacity to increase cell enlargement[3,4]**.** The effect of GA_3 has ,at least, three important actions, intensifies an organ ability to function as a nutrient sink, ability to increase the synthesis of IAA in tissues of plant and works on accelerating the synthesis of hydrolytic enzymes as amylase and other hydrolytic enzymes in aleurone cell[5]**.**

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[6].

Many studies have shown that nutrients spraying, especially zinc and gibberellic acid (GA3) are useful with respect to yield and fruit quality. Such as orange[7, 8], sweet cherry [9], guava[10], apple[11], and also on olive[12, 13, 14, 15]. [16]found that spraying Shengeh olive trees with gibberellic acid and zinc sulphate caused a significant improvement in fruit volume, weight and total yield. And also[17], noticed that the foliar application of GA3 and ZnSO4 significantly increased yield and oil production.

The aim of this work was to study the possibility of improving yield and fruit characteristics of Kalamata and Picual olive cultivars using gibberellic acid and zinc sulphate applications.

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 8 years old, grown in a sandy soil at planting distance of 5x5 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.

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, and 1% soluble soap was added as a wetting substance which was enough for thorough tree drenching.

The measurements:

1. Yield

The trees were harvested at black maturity stage and the yield as kg/ tree was determined.

2. Fruit quality

A sample of 30 fruits per tree was selected at random for the following determination**:**

1. 2. Fruit weight: By ordinary balance with 0.01 gm sensitivity.

2.2. Fruit volume: By water displacement method.

2.3. Flesh / stone ratio: Values were calculated by dividing the weight of the flesh over the weight of the stone.

2.4. Oil percentage: It was determined according to [18] method by extracting the oil from the dried flesh fruit with soxhelt apparatus using petroleum ether 60-80 º C of boiling point and expressed in percentage on dry weight basis.

All the obtained data were statistical analyzed according to Duncan's multiple rang test that was used to differentiate means at 5% [19].

Results and Discussions

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

1. Yield.

Concerning Kalamata cultivar, data in Table(1) revealed that, the two GA_3 concentrations caused a significant increase in tree yield (kg) when compared with the control, yet the difference between the two GA_3 concentrations was insignificant. This was true in the two studied seasons.

The yield of trees received the $ZnSO_4$ application differed from season to season, while it was slightly increased in the first season, it showed a very slight decreased in the second one comparing to that of the control.

Concerning the interaction between the two studied materials. All treatments caused an increase in tree yield, yet this increase was not significant in most cases. The only significant interaction was detected when the trees received the 40 ppm GA_3 + 0.5% $ZnSO_4$ in the first season or the GA_3 alone in the second season. These two treatments gave about 24 and 23 % increase respectively in tree yield comparing with control.

As for Picual cultivar, the GA_3 treatments caused significant increase the yield (kg/ tree) in the first season comparing with that of the control, yet this increase was not significant in the second season. As for $ZnSO_4$ application, the 1% concentration gave significant higher tree yield comparing with that of the control.

With respect to the interaction, significant increase in tree yield was due to spraying trees with GA_3 at 40 ppm coupled with $ZnSO_4$ at 1% (about 26% over the control) in the first season, yet this same GA3 concentration (40 ppm) alone showed the same increase value (about 26%) in the second season.

It is worthy to mention that, spraying GA_3 caused a pronounced increase in tree yield this increase was significant in over this of the control, most cases whereas the increase in tree yield due to $ZnSO_4$ applications was not pronounced in most cases.

Concerning the combined analysis, data of both cultivars showed that**,** the two GA_3 concentrations caused a significant increase in tree yield (kg) when compared with the control. Yet no significant difference was detected between y

ield from trees received the $ZnSO_4$ sprays. The maximum increase in yield of Kalamata (about 19%) and (about 22%) in Picual were obtained from trees received the GA_3 at 40 ppm alone.

In most cases, the effect of GA_3 at 40 ppm was always better that at 20 ppm either sprayed alone or in combination with $ZnSO_4$. This was true when considering the yield as (kg/ tree) of the two olive cultivars as (kg/ tree) in both seasons.

The obtained results of spraying GA_3 are in line with those reported by[20] on Sakkoty date palm**,** [7]on Washington navel orange, [13,14, 15]on olive and [21]on "Swelling" Peach trees who noticed that spraying GA_3 caused significantly increased yield.

The detected results of spraying $ZnSO_4$ are in agreement with that obtained by[22] on pear and [2]on black walnut who found that yield was not consistently influenced by zinc foliar fertilization.

Furthermore, our results of spraying GA_3 and $ZnSO_4$ are in harmony by [16] who reported that yield was significantly increased most by concentrations of GA_3 and $ZnSO_4$ treatments and use of 0.5% $ZnSO_4$ + 30 ppm GA_3 treatments was optimum for improvement of olive fruit yield.

2. Fruit weight and volume

From data in Table (2) all treatments increased average fruit weight when compared with the control, in general, effect of GA_3 sprays surpassed the effect of $ZnSO_4$ in this respect.

For the Kalamata trees, the increase in mean fruit weight reached (about 19%) in fruits from trees sprayed with GA_3 at 40 ppm coupled with $ZnSO_4$ at 0.5% in the first season, this increase reached (17%) in fruits from trees sprayed with GA3 alone in the second one.

Concerning Picual cultivars, the maximum increase in Picual fruits (about 23% over the control) was obtained from trees sprayed with GA_3 at 40 ppm coupled with 1% $ZnSO_4$ in the first season and (about 19%) from trees received GA_3 at 40 ppm alone in the second one.

Concerning the combined analysis, data cleared that GA_3 at the two tested concentrations (20 and 40 ppm) significantly increased mean fruits weight and volume in both cultivars. Yet no significant difference was detected between fruits from Kalamata olive trees received the $ZnSO_4$ sprays. The only significant difference in mean fruit weight and volume of Picual were noticed when the high $ZnSO_4$ concentration (1%) was applied. The maximum increase in Kalamata fruit weight (13 % than the control) was obtained in trees applied with GA_3 at 40 ppm alone and (about 19%) in Picual fruits from trees of GA_3 at 40 ppm coupled with $ZnSO_4$ at 1% treatment.

Concerning the effect of treatments on fruit volume (cm^3), data cleared the change in mean fruit volume followed about the same pattern.

The obtained results of spraying GA_3 are in line with that reported by[13, 14, 15] on olive who found that spraying trees with GA_3 resulted in significantly increased yield, fruit weight and volume. Similar results were confirmed by[20] on Sakkoty date palm, [7]on Washington navel orange and [21]on "Swelling" Peach trees, who noticed that spraying GA_3 caused significantly increased fruit weight.

The obtained results of spraying Kalamata olive trees with $ZnSO_4$ are in agreement with that obtained by[22] on pear who found that foliar application of Zinc did not cause any significant differences on the average of fruit weight. While The obtained results of spraying Picual olive trees with $ZnSO_4$ are in harmony with that obtained by [24,25] on Washington navel orange, [26]on *Citrus reticulata* Blanco cv. Feutrell's Early, [27]on 'Kinnow' mandarin tree and [28]on Pistachio, they obtained that spraying ZnSO4 significantly increased fruit weight, In addition, our results agree with [29,30,31] on olive and [32]on pecan, who found that fruit weight and volume increased by spraying $ZnSO_4$.

The obtained results of spraying GA_3 and $ZnSO_4$ are in harmony by[16, 17] on olive they reported that fruit weight was significantly increased most by concentrations of GA_3 and $ZnSO_4$ treatments.

3. Flesh/ stone ratio

As Kalamata cultivar, data in Table (3) indicated that GA_3 at both studied concentrations (20 and 40 ppm) significantly increased flesh/ stone ratio more than control, while there was no significant difference between both concentrations (20 and 40 ppm) ,this effect was true in both seasons.

With respect to the effect of spraying $ZnSO_4$, It could be seen that, the effect of $ZnSO_4$ on increasing flesh/ stone ratio was rather slight.

Interaction between spraying GA_3 and $ZnSO_4$ showed that, in the first season, flesh/ stone ratio reached its highest value in trees sprayed with (40 ppm GA_3 + 0.5 % $ZnSO_4$). While in the second season the highest flesh/ stone ratio was recorded with spraying 40 ppm GA_3 alone.

Concerning Picual cultivar, in the first season, flesh/ stone ratio was significantly increased by spraying GA_3 at both concentrations (20 and 40 ppm). The same trend was noticed in the second season.

Concerning the effect of spraying $ZnSO_4$ on flesh/ stone ratio, it could be seen that in the first season, spraying 1% $ZnSO_4$ significantly increased flesh/ stone ratio compared to control and the 0.5% concentration. While in the second season, both $ZnSO_4$ concentrations caused significant increase than the control.

By studying the combined statistical analysis the data noticed that flesh/ stone ratio was significantly increased by spraying 1% $ZnSO_4$.

Concerning interaction between spraying GA_3 and $ZnSO_4$, data showed that the highest flesh/ stone ratio was obtained from trees sprayed with (40 ppm GA_3 + 1%$ZnSO_4$) in both seasons. Otherwise, untreated trees gave the lowest values in both seasons.

Concerning the combined analysis, It could be seen that flesh/ stone ratio of Kalamata and Picual fruit was significantly affected by spraying GA_3 at both concentrations (20 and 40 ppm). As for spraying $ZnSO_4$, it could be observed that there were no significant differences in flesh/ stone ratio of Kalamata olive fruit when spraying with $ZnSO_4$, while flesh/ stone of Picual olive fruit was affected significantly by spraying 1% ZnSO4. The highest flesh/ stone value of Kalamata fruits was obtained from trees sprayed with (40 ppm GA_3+0.5% $ZnSO_4$), while treated Picual trees with (40 ppm GA_3+1 % $ZnSO_4$) gave the highest flesh/ stone value.

This finding agrees with[15] on olive who indicated that pulp/ pit ratio significantly increased when treated with spraying GA_3.

The obtained results of spraying ZnSO4 are in harmony by[30, 31] on olive who found that spraying $ZnSO_4$ 0.5% has a positive effect on improving pulp/ pit ratio.

4. Oil percentage (on dry weight basis):

Concerning Kalamata cultivar, the data in Table (4) indicated that in the first season, flesh oil percentage was increased significantly by spraying GA_3 at both concentrations (20 and 40 ppm) more than control and GA_3 sprayed at high concentration (40 ppm) was more effective than the lower one (20 ppm). Furthermore, in the second season spraying GA3 (20 and 40 ppm) seemed to have no significant effect on flesh oil percentage. Concerning, the combined statistical analysis, data indicated that, flesh oil percentage was increased significantly by spraying GA3 at both concentrations (20 and 40 ppm) more than control and GA_3 sprayed at high concentration (40 ppm) was more effective than the lower one (20 ppm).

As for $ZnSO_4$, in the first season flesh oil percentage value was significantly affected by spraying 1% $ZnSO_4$ compared with those of spraying 0.5% ZnSO4 and control. While in the second season, the results cleared that flesh oil percentage was slightly improved by spraying $ZnSO_4$ at (0.5%), while the flesh oil percentage was significantly increased by spraying ZnSO4 at 1% compared with control. Data of combined statistical analysis showed that, there were significant increases on flesh oil percentage when spraying $ZnSO_4$ either at 0.5% or 1%.

The data of interaction between spraying GA_3 and $ZnSO_4$ cleared that, in the first season spraying GA_3 at 40 ppm either alone or coupled with $ZnSO_4$ at 1% gave the highest flesh oil percentage these two treatments gave about 28 and 26% increase in flesh oil percentage over the control respectively. In the second, applying $ZnSO_4$ at 1% caused the highest flesh oil percentage which reached (about 10% over the control). This same concentration + GA_3 at 40 ppm resulted in (about 9%) increase in flesh oil percentage over the control.

Concerning Picual cultivar, in both seasons, the flesh oil percentage was significantly affected by spraying GA_3 at (40 ppm) compared with spraying GA_3 at (20 ppm) and control.

Concerning the effect of spraying $ZnSO_4$, the results indicated that in the first season, there were no significant differences in the flesh oil percentage between control and spraying $ZnSO_4$ at (0.5% and 1%). However, in the second season, it was noticed that the flesh oil percentage was significantly affected by spraying $ZnSO_4$ at both concentrations (0.5% and 1%). Meanwhile, the combined statistical analysis of the results clearly showed that the flesh oil percentage was significantly affected by spraying $ZnSO_4$.

Concerning the effect of interaction, it could be seen that in the first season applying GA_3 at 40 ppm either alone or in compensation with $ZnSO_4$ at 0.5% resulted in (about 15 and 12%) increase in flesh oil percentage than the control for the two treatments respectively. Whereas in the second season about 16% increase in flesh oil percentage was due to the GA_3 at 20 ppm plus $ZnSO_4$ at 1%.

Data of combined analysis showed that, fruits from trees received the GA_3 alone at the high concentration 40 ppm showed the greatest flesh oil percentage. This was true for both cultivars.

The results of spraying GA3 are in agreement with that obtained by[13,14,33,12] on olive trees; they reported that fruit oil percentage in dry weight was greatly increased by spraying GA3. The obtained results of spraying ZnSO4 are in harmony with that reported by[34] on almond, [32]on pecan nut and [35,31]on olive showed that the foliar application of zinc improved the oil content as a percentage of dry weight.

The results of spraying GA3 and Znso4 in line with that observed by[17] on olive they found that spraying with GA_3 in combination with $ZnSO_4$ increased the percentage of fruit oil on a dry weight basis

Table (1): Effect of spraying Kalamata and Picual olive trees with GA_3 acid and $ZnSO_4$ on yield during 2012&2013 seasons.

Yield (kg/ tree)												
	2012				2013				Combined analysis			
$ZnSO_4$ / GA_3	0%	0.5%	1%	Mean	0%	0.5%	1%	Mean	0%	0.5%	1%	Mean
	Kalamata											
0 ppm	27.00c	29.50bc	27.50 c	**28.00B**	29.75 c	31.25bc	30.75 bc	**30.58B**	28.38 c	30.38bc	29.13 c	**29.30B**
20 ppm	30.25abc	32.00ab	31.25ab	**31.17A**	34.25ab	32.75abc	32.25 bc	**33.08A**	32.25ab	32.38ab	31.75ab	**32.13A**
40 ppm	31.00ab	33.50 a	32.25ab	**32.25A**	36.50 a	32.25 bc	33.25abc	**34.00A**	33.75 a	32.88ab	32.75ab	**33.13A**
Mean	**29.42 A**	**31.67A**	**30.33A**		**33.50A**	**32.08 A**	**32.08 A**		**31.46A**	**31.88A**	**31.21A**	
	Picual											
0 ppm	16.40 b	17.60ab	19.00ab	**17.67B**	18.00 c	19.40 bc	21.00abc	**19.47A**	17.20 c	18.50bc	20.00ab	**18.57B**
20 ppm	18.20ab	18.40ab	19.60 a	**18.73A**	22.00ab	20.20abc	18.60 c	**20.27A**	20.01ab	19.30ab	19.10b	**19.47AB**
40 ppm	19.20ab	18.80ab	20.60 a	**19.53A**	22.60 a	20.40abc	19.20bc	**20.73A**	20.90 a	19.60ab	19.90ab	**20.13 A**
Mean	**17.93B**	**18.27B**	**19.73A**		**20.87A**	**20.00 A**	**19.60 A**		**19.37A**	**19.13A**	**19.67A**	

Mean in each column with similar letter(s) is not significantly different at 5 % level.

Table (2): Effect of spraying Kalamata and Picual olive trees with GA_3 and $ZnSO_4$ on fruit weight and volume during 2012&2013 seasons.

ZnSO4 / GA3	2012				2013				Combined analysis			
	0%	**0.5%**	**1%**	**Mean**	**0%**	**0.5%**	**1%**	**Mean**	**0%**	**0.5%**	**1%**	**Mean**
	Kalamata											
	Fruit weight (g)											
0 ppm	6.31 c	6.63 bc	6.55 bc	**6.50 B**	6.93 d	7.52 b	7.03 cd	**7.16 B**	6.62 c	7.08 ab	6.79 bc	**6.82 B**
20 ppm	6.74abc	7.18 ab	7.12ab	**7.01 A**	7.69 ab	7.49 b	7.63 b	**7.60 A**	7.22 ab	7.34ab	7.38 ab	**7.31 A**
40 ppm	6.89 ab	7.50 a	7.22ab	**7.2 0A**	8.08 a	7.37 bc	7.29bcd	**7.58 A**	7.49 a	7.44 a	7.26 ab	**7.39 A**
Mean	**6.65 B**	**7.10A**	**6.96AB**		**7.57 A**	**7.46AB**	**7.31 B**		**7.11 A**	**7.29 A**	**7.14 A**	
	Volume(cm^3)											
0 ppm	6.07 c	6.40 bc	6.28 bc	**6.25 B**	6.52 c	7.18 b	6.69 c	**6.76 B**	6.30 c	6.79 ab	6.44 bc	**6.51 B**
20 ppm	6.57abc	6.94 ab	6.96 ab	**6.82 A**	7.34 b	7.16 b	7.24 b	**7.25 A**	6.96 ab	7.05 ab	7.10 ab	**7.04 A**
40 ppm	6.63abc	7.32 a	7.06 ab	**7.00 A**	7.74 a	6.96 bc	7.09 b	**7.26 A**	7.19 a	7.14 ab	7.08 ab	**7.13 A**
Mean	**6.42 B**	**6.89 A**	**6.77AB**		**7.20A**	**7.10AB**	**6.97 B**		**6.82 A**	**6.99 A**	**6.87A**	
	Picual											
	Fruit weight (g)											
0 ppm	7.37 d	7.96 c	8.51 b	**7.95 C**	7.26 c	7.88 b	8.00 ab	**7.71 B**	7.32 d	7.92 c	8.25bc	**7.83 C**
20 ppm	8.00 c	8.38bc	8.62 b	**8.33 B**	8.19 ab	8.06 ab	8.35 ab	**8.20 A**	8.10 c	8.22 bc	8.49 ab	**8.27 B**
40 ppm	8.48b	8.24 bc	9.08 a	**8.60 A**	8.42 a	8.25 ab	8.31ab	**8.33 A**	8.45 ab	8.25 bc	8.70 a	**8.47A**
Mean	**7.95 B**	**8.19 B**	**8.74 A**		**7.96 A**	**8.06A**	**8.22 A**		**7.96 B**	**8.13 B**	**8.48 A**	
	Volume(cm^3)											
0 ppm	7.13 d	7.65 c	8.01 bc	**7.60 B**	6.97 c	7.58 b	7.61 b	**7.39 B**	7.05 e	7.62 d	7.81 cd	**7.49 C**
20 ppm	7.74 c	8.04 bc	8.34 ab	**8.04 A**	7.83 ab	7.71 ab	7.95 ab	**7.83 A**	7.79 cd	7.88bcd	8.15 ab	**7.94B**
40 ppm	8.01bc	7.92 bc	8.75 a	**8.23 A**	8.13 a	7.93 ab	7.99 ab	**8.02 A**	8.07 bc	7.93 bc	8.37 a	**8.12 A**
Mean	**7.63 B**	**7.87 B**	**8.37 A**		**7.64 A**	**7.74 A**	**7.85 A**		**7.64 B**	**7.81 B**	**8.11 A**	

Mean in each column with similar letter(s) is not significantly different at 5 % level.

Table (3): Effect of spraying Kalamata and Picual olive trees GA_3 and $ZnSO_4$ on flesh/ stone during 2012&2013 seasons.

Flesh/ stone ratio												
	2012				2013				Combined analysis			
ZnSO4 / GA3	0%	0.5%	1%	Mean	0%	0.5%	1%	Mean	0%	0.5%	1%	Mean
Kalamata												
0 ppm	5.01 b	5.25 ab	5.12ab	**5.13B**	5.60 d	5.96 cd	5.57 d	**5.71 B**	5.31 d	5.61bcd	5.35 cd	**5.42B**
20 ppm	5.13ab	5.59ab	5.65 ab	**5.46 A**	6.39 ab	6.27abc	6.27abc	**6.31 A**	5.76abc	5.93 ab	5.96 ab	**5.88 A**
40 ppm	5.56 ab	5.94 a	5.56 ab	**5.69 A**	6.62 a	6.30abc	6.15 bc	**6.36 A**	6.09 a	6.12 a	5.86 ab	**6.02 A**
Mean	**5.25 B**	**5.59 A**	**5.44AB**		**6.20 A**	**6.18 A**	**6.00 A**		**5.72 A**	**5.88 A**	**5.72 A**	
Picual												
0 ppm	6.23 d	6.65 cd	7.03 bc	**6.64 C**	5.79 c	6.58ab	6.62 ab	**6.33 B**	6.01 d	6.62 c	6.83 bc	**6.49 B**
20 ppm	6.62 cd	6.91 bc	7.45ab	**6.99 B**	6.95 a	6.68 ab	6.73 ab	**6.79 A**	6.79 bc	6.80 bc	7.09 ab	**6.89 A**
40 ppm	7.31 ab	7.32 ab	7.82 a	**7.48 A**	6.65 ab	6.45 b	6.99 a	**6.70 A**	6.98 bc	6.89 bc	7.41 a	**7.09 A**
Mean	**6.72 B**	**6.96 B**	**7.43 A**		**6.46 B**	**6.57AB**	**6.78 A**		**6.59 B**	**6.77 B**	**7.11 A**	

Mean in each column with similar letter(s) is not significantly different at 5 % level

Table (4): Effect of spraying Kalamata and Picual olive trees with GA_3 and $ZnSO_4$ on oil percentage (on dry weight basis) during 2012&2013 seasons.

Oil %												
	2012				2013				Combined analysis			
$ZnSO_4$ / GA_3	0%	0.5%	1%	Mean	0%	0.5%	1%	Mean	0%	0.5%	1%	Mean
Kalamata												
0 ppm	41.26 f	44.03de	45.47cd	**43.59 C**	39.54 d	41.26abcd	43.19 a	**41.33 A**	40.40 e	42.65 cd	44.33 b	**42.46 C**
20 ppm	43.14 e	47.18 b	47.13 b	**45.81 B**	40.57 cd	41.86abc	40.63cd	**41.02A**	41.85 d	44.52 b	43.88 bc	**43.42 B**
40 ppm	52.82 a	46.86 bc	51.94 a	**50.54 A**	42.34abc	40.90bcd	42.98ab	**42.08 A**	47.58 a	43.88 bc	47.46 a	**46.31 A**
Mean	**45.74 B**	**46.02 B**	**48.18 A**		**40.82 B**	**41.37AB**	**42.26 A**		**43.28 B**	**43.68 B**	**45.22 A**	
Picual												
0 ppm	46.53 g	48.76ef	51.31bc	**48.87 B**	42.02 e	47.67ab	46.24bc	**45.31B**	44.27 e	48.22 c	48.78 bc	**47.09 C**
20 ppm	48.03 fg	50.21cde	50.58bcd	**49.61 B**	43.52 d	45.72 c	48.85 a	**46.03B**	45.77 d	47.97 c	49.72 ab	**47.82 B**
40 ppm	53.37 a	52.00ab	49.29def	**51.55 A**	47.03 bc	47.66ab	46.63bc	**47.11A**	50.20 a	49.83 ab	47.96 c	**49.33 A**
Mean	**49.31 B**	**50.32 A**	**50.39 A**		**44.19 B**	**47.02 A**	**47.24 A**		**46.75 B**	**48.67 A**	**48.82 A**	

Mean in each column with similar letter(s) is not significantly different at 5 % level

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