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Influence of Spraying Zinc Sulphate before and During Blooming Stage on Fruit Quality and Quantity of "Manzanillo" Olives

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Abstract This study was carried out during the two successive seasons (2011 and 2012) on olive treesManzanillo cv. The trees were 10 years old growing in sandy soil at a private orchard in Ismailia governorate, Egypt. This investigation was performed to study the effect of zinc sulphate on olive trees Manzanillo cv., zinc sulphate concentration (0, 0.25 and 0.5%) was used as foliar application once time at pre-blooming (early March) or at full bloom (early April) or at pre-blooming + full bloom. At the end of the season, yield (kg/tree) and Fruit quality: average fruit size (volume), weight, shape index (length\ diameter), pulp\pit ratio, fruit oil and acidity percentage were recorded. The obtained results showed that, Manzanillo olive trees received zinc sulphate at 0.5% has positive effect on fruit characteristics in terms of fruit weight and fruit oil % and the total fruit yield per tree.

Keywords: Olive Manzanillo cv., yield, fruit quality, fruit oil percentage, fruit acidity percentage, flowering period, zinc sulfate

Introduction

Olive tree (*Oleaeuropaea* L.) of the Oleaceae family has a high economic value and considered one of the important fruit crops in Egypt. Olive is very well adapted to the high temperature; tolerate dry weather, high soil salinity levels and infertile soil. The size of the fruit is important, not only because it is

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a component of productive yield, but also determines the acceptance by the consumer as conserved fruits. Zinc is a component of almost 60 enzymes; it has a role in producing the growth hormone IAA. Zinc plays a key role in N metabolism of plant and Zn deficient plants have reduced protein content (Hassan *et al*., 2010 and Mengel *et al*., 2011). Copper is essential for the growth of plant and helps in the formation of vitamin A Martensand Westermann (1991). Various studies have shown that nutrient elements sprays, especially zinc had beneficial effects with respect to yield and fruit quality. In manly fruit crops, such as orange (Abd El-Migeed, 2002; Tumminelli *et al*., 2005, Sayed *et al*., 2004; Eman *et al*., 2007), sweet cherry (Usenik and Stampar, 2002), guava (El-Sharkawy and Mehaisen, 2005), apple (Neilsen and Neilsen, 2002), and also, to a limited degree, the olive (Cimato *et al.*, 1990; Toscano *et al*., 2002; Jordão and Lietão, 1990). In order to improve the nutritional status of olive trees during the fruit development period, a summer foliar application of nutrients was suggested (Cimato *et al*., 1990). El-Khawaga (2007) reported that micronutrient spraying increased the yield, average fruit weight, pulp weight, and oil % of 'Manzanillo' olives. Talaie and Taheri (2001) showed that foliar sprays of B and Zn significantly decreased fruit drop and improved fruit quality in 'Zard' olives. Jordão and Lietão (1990) reported that there was a positive correlation between the fruit Zn concentration and the weight of oil content of olive fruit. Foliar spray of zinc sulphate is advantageous over soil application, because of rapid response, effectiveness. Results indicated that spraying the trees twice or thrice is more effective than spraying once a year in improving micronutrients content of peach trees El-Sheikh *et al.* (2007).

This study was aimed to study the effect of zinc sulphate spray before and during Blooming Stage on Fruit Quality and Quantity of "Manzanillo" Olives.

Materials and methods

This study was conducted during two successive seasons, 2011 and 2012, on 10 years old olive trees Manzanillo cv. Trees were similar as possible in vigor, age and size were chosen for sprays treatments. The selected trees were grown in a private orchard in Ismailia Governorate, Egypt. The trees spaced 5 x 5 meter (168 trees\ acre) in a sandy soil (Table 1) under drip irrigation system (consisted of two lateral lines per row, separated by 1.0 m). The trees were

received the same cultural practicesaccording to the recommendations of the Ministry of Agriculture. The farm is depending on well in irrigation (Table 2). Zinc sulphate (0, 0.25 and 0.5%) were sprayed once at pre-blooming (P.B) period (early March)or at full bloom (F.B) period (early April) or at pre-blooming + full bloom periods (P.B + F.B).Seven treatments were applied in three replicates.Complete randomized block design was adopted.

Fruit physical characteristics

In both seasons at harvest time (mid Sept.) samples of 100 random mature fruits per tree were used for the determination of average fruit size (volume cm_3), weight (gm), shape index (length\ diameter),Fruit moisture percentage , pulp\pit ratio and oil percentage in fresh and dry weight of fruit. Fruit oil content was determined by means of the Soxhlett fat extraction apparatus using Hexan of 60-80℃ boiling point as described by (A.O.A.C. 1975).

Yield: Olive trees Manzanillo cv. Yield was measured as Kg/tree.

Fruit chemical characteristics

Fruit acidity percentage :total acidity % as Malic acid (mg/100 gm fruit juice) according to AOAC (1975).

Data Analysis

The obtained data during the two seasons of the study was statistically analyzed of variance method; differences between means were compared using Duncan's multiple range tests at 0.05 level according (Duncan, 1955).

Table 1. Chemical characteristics of sandy soil used for the present study.

Parameters	*Surface sample*	*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)			
$CO3^{=}$	-	-	-
$HCO3^{-}$	4.40	2.40	2.00
Cl^{-}	27.20	5.00	13.00
$SO4^{=}$	7.12	1.14	3.18

Table 2. Chemical characteristics of water weal used 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^{+}	33.10
K^{+}	0.16
Soluble anions (meq\l)	
$CO3^{=}$	-
$HCO3^{-}$	1.60
Cl^{-}	40.00
$SO4^{=}$	4.16

Results and discussion

As shown in Table (3) it is clear that fruit weigh and volume were increased significantly by both zinc sulfate concentrations compared with the control. Generally, zinc sulfate sprayed at the high concentration (0.5%) was more effective than the lower one (0.25%), this impact was more obviousness when sprayed at full bloom stage wherezinc sulfate at 0.5%, recorded the highest values of that fruit weigh and volume in both seasons compared with control. **Ramezani and Shekafandeh (2009)** reported similar findings and indicatedthatfruit weight of **Olive trees (*Olea europaea* L. cv. Shengeh)** was significantly increased by most concentrations of GA3 and ZnSO4 treatments with respect to control trees, due to an increase in fruit size.

Table 3. Effect of foliar application of zinc sulphate on weight and size (volume) of fruit olive trees Manzanillo cv.

Treatment		Fruit weight (gm)		Fruit volume (cm^3)	
		2011	2012	2011	2012
Control (sprayed with water)		4.05 c	4.38 d	3.93 d	4.25 e
P.B	0.25 % $ZnSO_4$	5.34 b	6.03 b	5.22 b	5.94 b
	0.5 % $ZnSO_4$	5.66 b	6.48 b	5.33 b	6.38 b
F.B	0.25 % $ZnSO_4$	5.20 b	6.13 b	5.11 b	5.99 b
	0.5 % $ZnSO_4$	6.55 a	7.01 a	6.25 a	6.80 a
P.B + F.B	0.25 % $ZnSO_4$	4.63 b	4.97 c	4.49 c	4.78 d
	0.5 % $ZnSO_4$	4.81 b	5.53 b	4.63 c	5.32 c
Means of	P.B	5.02 A	5.63 A	4.83 A	5.52 A
spraying time	F.B	5.27 A	5.84 A	5.10 A	5.68 A
	P.B + F.B	4.50 B	4.96 B	4.35 B	4.78 B
Means of	0 % $ZnSO_4$	4.05 C	4.38 C	3.93 C	4.25 C
$ZnSO_4$	0.25 % $ZnSO_4$	5.06 B	5.71 B	4.94 B	5.57 B
concentrations	0.5 % $ZnSO_4$	5.67 A	6.34 A	5.40 A	6.17 A

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

As shown in Table (4) pulp\pit ratio was increased by zinc sulfate treatments in both seasons compared with control. The highest pulp\pit ratio value was obtained from olive trees sprayed with zinc sulfate at 0.25% during pre-blooming stage.Whereas, pulp\pit ratio values behaved an opposite manner when olive trees sprayed with zinc sulfate at high concentration (0.5%) and recorded high pulp\pit ratio values higher than those obtained from trees sprayed with zinc sulfate at low concentration (0.25%)at pre-blooming and full bloom stages, but the differences lacked significance. With respect to shape index (length\ diameter) it is clear that, shape index of Manzanillo fruits tended to increase due to zinc sulfate sprays compared with the control. These findings agrees with Ramezani and Shekafandeh (2011) who reported that The highest fruit, pulp and pulp/pit volume were obtained from trees treated with 0.5% $ZnSO_4$.

With respect to fruit acidity percentage it is clear in Table (5) that foliar application of zinc sulfate at both studied concentrations (0.25 and 0.5%) significantly increased fruit acidity percentage more than control. Generally, no significant differences in fruit acidity percentage were noticed due to zinc sulfate concentrations applied. Generally, both low and high zinc sulfate treatments gave more or less fruit acidity percentage values smeller from the statistical stand point

Fruit moisture content as shown in Table (5) was increased by zinc sulfate sprays, this effect was more clearer at 0.5% concentration when compared with the low one (0.25%) specially when applied at pre-bloom stage, this effect was truein both seasons

With respect to fruit oil percentage, data in Table (6) indicated that oil percentage in fresh and dry weight of fruitwas markedly influenced by the concentration of zinc sulfate used, highest fruit oil percentage was obtained from fruits taken from trees sprayed with zinc sulfate at the low concentration specially when sprayed at pre-bloom stage, this trend was also noticed when olive trees sprayed at both of pre-bloom and full bloom stages, but the differences lacked significance

Table 4. Effect of foliar application of zinc sulphate on fruit pulp\pit ratioand shape index (length\ diameter) of olive trees Manzanillo cv.

Treatment		fruit Pulp / Pit ratio		fruit shape index (length\ diameter)	
		2011	2012	2011	2012
Control (sprayed with water)		3.99 d	4.45 d	1.19 b	1.21 b
P.B	0.25 % $ZnSO_4$	5.96 a	6.17 a	1.25 b	1.3 ab
	0.5 % $ZnSO_4$	5.28 b	5.54 b	1.22 b	1.28 ab
F.B	0.25 % $ZnSO_4$	4.68 c	5.08 bc	1.34 a	1.27 ab
	0.5 % $ZnSO_4$	4.95 bc	5.63 b	1.23 b	1.31 ab
P.B + F.B	0.25 % $ZnSO_4$	4.48 cd	4.81 cd	1.26 ab	1.35 a
	0.5 % $ZnSO_4$	5.06 bc	5.13 bc	1.25 b	1.27 ab
Means of spraying time	P.B	5.08 A	5.39 A	1.22 A	1.26 A
	F.B	4.54 B	5.05 B	1.25 A	1.26 A
	P.B + F.B	4.51 B	4.79 C	1.23 A	1.29 A
Means of $ZnSO_4$ concentrations	0 % $ZnSO_4$	3.99 B	4.45 B	1.19 B	1.21 B
	0.25 % $ZnSO_4$	5.04 A	5.35 A	1.28 A	1.31A
	0.5 % $ZnSO_4$	5.10 A	5.43 A	1.23 A	1.29 A

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

Table 5. Effect of foliar application of zinc sulphate on Fruit acidity and moisture percentage of olive trees Manzanillo cv.

Treatment		Fruit acidity %		Fruit moisture %	
		2011	2012	2011	2012
Control (sprayed with water)		1.02 c	0.77 c	57.25 c	58.46 c
P.B	0.25 % $ZnSO_4$	1.49 a	1.07 a	59.76 ab	58.77 bc
	0.5 % $ZnSO_4$	1.59 a	0.99 ab	61.31 a	61.70 a
F.B	0.25 % $ZnSO_4$	1.47 ab	1.05 a	58.83 bc	60.73 ab

	0.5 % $ZnSO_4$	1.25 b	1.06 a	60.78 a	62.11 a
P.B + F.B	0.25 % $ZnSO_4$	1.41 b	0.98 ab	58.84 bc	58.30 c
	0.5 % $ZnSO_4$	1.60 a	1.01 a	59.66 ab	60.97 ab
Means of	P.B	1.37 A	0.94 A	59.39 A	59.64 A
spraying time	F.B	1.25 A	0.96 A	58.95 A	60.43 A
	P.B + F.B	1.34 A	0.92 A	58.58 A	59.24 A
Means of	0 % $ZnSO_4$	1.02 B	0.77 B	57.25 B	58.46 B
$ZnSO_4$	0.25 % $ZnSO_4$	1.46 A	1.03 A	59.09 AB	59.27 B
concentrations	0.5 % $ZnSO_4$	1.48 A	1.02 A	60.58 A	61.59 A

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

On the contrary, olive trees sprayed with 0.5% zinc sulfate at full bloom stage behaved an opposite manner in fruit oil percentage values, where this treatments yielded higher fruit oil percentage content when compared with the low zinc sulfate concentration treatment (0.25%), this was true in both seasons. overall improvement in fruit weight, size and pulp pit ratio in the present study might be responded for increased oil content in oil fruit and the results obtained are in consonance with the findings of Jordão and Lietao (1990) who reported that there was a positive correlation between zinc concentration and the weight and oil content of the olive fruit. These findings agrees with Jasrotia *et al*., (2014) who reported that foliar application of zinc sulfate in combination with boric acid resulted in better growth, physical characteristics and oil content of olive fruit.

Concerning yield it is obvious from data in Table (7) that Manzanillo olive highly responded to zinc sulfate sprayed at both concentrations. However, the higher zinc sulfate concentration (0.5%) used the highest yield obtained.The highest yield of Manzanillo olive trees was obtained from trees sprayed with zinc sulfate at 0.5% during pre- bloom stage. This positive effect zinc sulfate at 0.5% (high concentration) of was noticed with a little extend when zinc sulfate foliar spray treatments applied at pre-bloom + full bloom periods. These results agree with Ramezani and Shekafandeh (2009) and Hagagg *et al.* (2014) whichindicated that use of 0.5% ZnSO4 treatment was optimum for improvement of olive fruit yield.

Table 6. Effect of foliar application of zinc sulphate on oil percentage in fruit fresh and dry weight of olive trees Manzanillo cv.

Treatment		Oil %in fruit dry weight		Oil % in fruit fresh weight	
		2011	2012	2011	2012
Control (sprayed with water)		26.21 e	24.33e	11.20 d	10.11 d
P.B	0.25 % $ZnSO_4$	38.24 a	37.73a	15.39 a	15.56 a
	0.5 % $ZnSO_4$	29.57 d	27.40 d	11.44 d	10.49 d
F.B	0.25 % $ZnSO_4$	32.67 c	30.93bc	13.45 bc	12.15 c
	0.5 % $ZnSO_4$	35.62 b	32.43b	13.97 b	12.29 c
P.B + F.B	0.25 % $ZnSO_4$	33.42 bc	32.53bc	13.76 b	13.57 b
	0.5 % $ZnSO_4$	31.27 c	30.53c	12.61c	11.92 c
Means of spraying time	P.B	31.34 A	29.82 A	12.68 A	12.05 A
	F.B	31.50 A	29.23 A	12.87 A	11.52 A
	P.B + F.B	30.30 A	29.13 A	12.52 A	11.87 A
Means of $ZnSO_4$ concentrations	0 % $ZnSO_4$	26.21 C	24.33 C	11.20 C	10.11 C
	0.25 % $ZnSO_4$	34.78 A	33.73 A	14.20 A	13.76 A
	0.5 % $ZnSO_4$	32.15 B	30.12 B	12.67 B	11.57 B

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

Table 7. Effect of foliar application of zinc sulphate on tree yield (Kg/tree) of olive trees Manzanillo cv.

Treatment		Yield of tree (kg)	
		2011	2012
Control (sprayed with water)		38.24 e	31.00 d
P.B	0.25 % $ZnSO_4$	41.58 d	49.18 bc
	0.5 % $ZnSO_4$	64.33 a	62.51 a
F.B	0.25 % $ZnSO_4$	48.80 c	50.65 bc

	0.5 % $ZnSO_4$	58.21 b	54.00 b
P.B + F.B	0.25 % $ZnSO_4$	46.85 c	45.25 c
	0.5 % $ZnSO_4$	57.50 b	53.33 b
Means of	P.B	48.05 A	47.56 A
spraying time	F.B	48.41 A	45.22 A
	P.B + F.B	47.53 A	43.19 A
Means of	0 % $ZnSO_4$	38.24 C	31.00 C
$ZnSO_4$	0.25 % $ZnSO_4$	45.74 B	48.36 B
concentrations	0.5 % $ZnSO_4$	60.01 A	56.61 A

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

Conclusion

The application rate and proper time of application of nutrient elements i.e. zinc sulphate is still a limiting factor in achieving the desired purpose where it seems that spraying zinc sulphate was more effective in improving quantity and quality. So, it might be concluded from the present study that ZnSo4 at 0.5 applied as foliar spray before flowering followed by foliar application during full bloom is recommended to increase yield and improve fruit quality of Manzanillo olive trees. These, result was in agreement with Ramezani and Shekafandeh (2009) who stated that, the improvement occurred in the fruit yield and quality could be attributed to effects of nutrients on carbohydrate influx or plant growth regulators synthesis in growing fruits. The results have revealed that nutrient spray applications can also cause yield and fruit quality improvement. application 0.5% ZnSO4 at third stage of fruit growth stimulated cell enlargement in the mesocarp of ‘Shengeh’ olive fruit, which in turn, caused a significant improvement in fruit size, weight and total yield. Whereas, applying zinc to the trees improved fruit quality by enhancing formation and translocation of carbohydrates and carbohydrate enzymes (Yogeratnam and Greenham, 1982). From the results mentioned above, it could be concluded that zinc as a micronutrient has effect on fruit characteristics in terms of fruit weight and fruit oil %. Also increase in individual fruit weight raised the total fruit yield per tree. On the other hand, total fruit oil per tree increases as a result of

increasing oil % and fruit weight, it is obvious that there is an opposite relationship between oil and moister percentage in Manzanillo olive fruit, where the higher oil percentage the lower moister percentage.

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