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Influence of Spraying Zinc Sulphat and Gibbralic Acid on Yield and Fruit Properties of "Manzanillo" Olives

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Abstract This study was carried out during the two seasons 2013, 2014 on olive trees Manzanillo 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 sulphat and gibbralic acid (GA3) on olive trees Manzanillo cv. Zinc sulphat (0, 0.25 and 0.5%) was used as foliar application once time before flowering period and gibbralic acid (0 and 0.25 ppm) was sprayed once time after fruit set. At the end of the season, yield (kg/tree) and Fruit quality: average fruit size (volume), weight, shape index (length\ diameter) and pulp\pit ratio also fruit chemical characterizes: fruit oil and acidity percentage were recorded. It is clear from data obtained that the response of Manzanillo olive trees to zinc sulphat spraying depended on the time of application as well as the concentration used, where full bloom is a suitable time for zinc sulphat to increase or improve physical fruit quality in terms of fruit weight (gm), volume (cm3) and pulp/pit. Meanwhile, zinc sulphat at 0.5% and gibbralic acid as a growth regulator at 10 ppm is recommended for increasing fruit weight and oil %, reduction in fruit drop, yield per tree.

Keyword: Olive Manzanillo cv., zinc sulfate , Gibberellic acid

Introduction

Olive tree (*Olea europaea* 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

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because it is a component of productive yield, but also determines the acceptance by the consumer as conserved fruits.

Gibberellins are known for their ability to increase cell enlargement (Arteca, 1996; Davis, 2004; Pharis and King, 1995), so enhancing fruit growth in certain species such as citrus (Eman *et al*., 2007; El-Sese, 2005), litchi (Stern and Gazit, 2000; Chang and Lin, 2006), guava (El-Sharkawy and Mehaisen, 2005) and pear (Zhang *et al*., 2007). In all species so far studied, gibberellins had the potential for increasing fruit size. The beneficial effects of Gibberellic acid (GA3) and nutrient elements sprays specially zinc on yield and fruit quality of different fruit crops were mentioned by many investigators including Swietlik (2002). Also, the use of GA3 as a growth regulator to promote size and to control fruit drop was reported by Arteca (1996). Swietlik (2002) was stated that soil applications of zinc are not very effective because the roots of fruit crops occupy deep soil layers and zinc does not easily move in the soil. Therefore, foliar sprays of zinc are more effective.

Various studies have shown that nutrient elements sprays, especially zinc and gibberellic acid (GA3), had beneficial effects with respect to yield and fruit quality, nutritional status, fruit set, and in reducing fruit drop. 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.

Since no report has been published as to the effect of gibberellic acid on fruit size of olive, and a few report about zinc effect on olive fruit characteristics was available. The aim of this work was to study the possibility

of increasing fruit size, yield and improvement of fruit characteristics in Manzanillo olive cultivar fruit by treatment with gibberellic acid and zinc sulphate applied in third stage of fruit growth.

Materials and methods

This study was conducted during two successive seasons, 2013 and 2014, on 10 years old olive trees Manzanillo cv Grown in a private orchard in Ismailia – Egypt. Really in vigour, age and size were selected for sprays treatments. 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 practices that are recommended. The farm is depending on well in irrigation (Table 2). Zinc sulphat (0, 0.25 and 0.5%) sprayed once time before flowering period and gibbralic acid (0 and 0.25 ppm) sprayed once time after fruit set.

Complete randomized block design was adopted. Six treatments were applied in three replicates. All of the 18 trees conducted in this study were vigorous and similar in growth and canopy.

- *Fruit physical Properties:*

In both seasons samples at harvest time of 100 random mature fruits per tree were used for the determination of fruit physical Properties:

1. average fruit size (volume)
2. weight, shape index (length\ diameter)
3. Fruit moisture percentage
4. pulp\pit ratio

- *Fruit chemical characteristics:*

1. Fruit oil percentage:
   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).
2. Fruit acidity percentage:
   Fruit juice total acidity % as Malic acid (mgs/100 gm fruit juice) according to A.O.A.C (1975).

- *yield:*

olive trees Manzanillo cv. Yield was measured as Kg/tree.

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).

Results

Fruit weight: Data in Table (3) proved that weight of fruits increased significantly by Zinc Sulphat and or Gibbralic Acid treatments in both seasons compared with the control. Highest weight of fruit was obtained when olive trees sprayed with 0.5% $ZnSo_4$ at full bloom stage followed by 10 ppm GA3 one month later. Weight of fruit recorded 6.31 and 7.25 gm. compared with control (4.61 and 4.70 gm) in the first and second seasons respectively.

Fruit volume: Data in Table (3) proved that Volume of fruit followed the same trained obtained in weight of fruit in both studied seasons. Highest fruit volume was obtained when olive trees sprayed with 0.5% $ZnSo_4$ at full bloom stage followed by 10 ppm GA3 one month later, volume of fruit recorded 6.25 and 6.67 cm3 compared with control (4.5 and 4.57 cm3) in the first and second seasons respectively.

Fruit pulp pit ratio:It is clear from Table (4) proved that that pulp pit ratio responded to $ZnSo_4$ spraying times at the high concentration (0.5%) where highest pulp pit ratio values were obtained from spraying olive trees twice (once at pre booming stage and second at full bloom stage). Highest pulp pit ratio recorded 6.44 and 5.07 by spraying olive trees with $ZnSo_4$ at 0.5% at pre booming and full bloom stages accompanied with GA_3 at 10ppm at one month after full bloom compared with the control which recorded 4.57 and 3.17 (in the first and second seasons respectively).

Fruit shape index (length\diameter): From the results in table (4) it seems that shape index (length\ diameter) was improved slightly but not significantly by most treatments specially these including GA_3.

Fruit acidity percentage: Data in Table (5) cleared that $ZnSo_4$ sprayed at pre-blooming stage gave the lowest values; where acidity percentage recorded 0.77 and 0.91 compared with the control which recorded 1.18 and 1.68 for acidity % values in the first and second seasons respectively.

Fruit moisture percentage: It is clear from data in Table (5) that Manzanillo olive fruits moisture decreased significantly due to zinc sulphate sprays. Generally the lowest moisture percentage values were obtained from fruits taken from trees sprayed with 0.5% zinc sulphate at full bloom stage.

Fruit Oil percentage: Results in Table (6) clearly showed that oil percentage significantly increased by zinc sulphat at the high concentration (0.5%) especially when applied at pre- blooming stage, where oil percentage recorded 40.30 and 37.87% compared with the control which recorded 31.33 and 30.50 %in the first and second seasons respectively.

Yield: Yield (Kg/ tree) increased significantly by $ZnSo_4$ sprays treatments, Table (7). However no significant differences were obtained in yield when comparing the yield obtained when trees were sprayed at pre- blooming stage or at pre- bloom + full bloom stages, where yield values were similar from the statically stand point.

Discussion

It is clear from data obtained that application rate and proper time of application of zinc sulphate and Gibbralic Acid is still a limiting factor in achieving the desired purpose where it seems that spraying zinc sulphate followed by GA3 was more effective in improving quantity and quality of olive than spraying one of them individually. however the obtained results 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. In conclusion, our results shown that application of 30 ppm GA3 along with 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. The role of GA3 in improving fruit quality namely, fruit shape index

(length\ diameter) may be explaned due to its role in increasing cell elongation (Pharis and King, 1995).The reduction in oil acidity due to increasing zinc sulphate concentrations from 0.25 up to 0.5% at pre-blooming stage but this also depended on time of application, this means that, improved olive acidity could be obtained when ZnSo4 sprayed only at pre-booming stage. Whereas, applying zinc to the trees improved fruit quality by enhancing formation and translocation of carbohydrates and carbohydrate enzymes (Yogeratnam and Greenham, 1982). The role of GA_3 in improving the fruit (flesh weight and fruit diameter) may be due to its role in increasing cell elongation (Pharis and King, 1995). Our results for GA3 sprays concur with those reported by El-Sese (2005), who found that 'Balady' mandarin trees sprayed with GA_3 increased yield, fruit number, and fruit weight.

Also it is clear from data obtained that the response of Manzanillo olive trees to time of zinc sulphat spraying depended on time of application as well as the concentration used, where full bloom is considered the suitable time for zinc sulphat to increase or improve physical fruit quality in terms of fruit weight (gm), volume (cm3) and pulp/pit. This findings agree with thou obtained by Laila Haggag (2014).

So, increase yield and improve fruit quality of Manzanillo olive trees due to ZnSo4 at 0.5 applied as foliar spray once at pre-bloom stage followed by foliar application of GA_3 at 10 ppm after fruit set in harmony with results obtained by Laila Haggag (2014).

Conclusion

It could be concluded that zinc as a micronutrient and gibberellic acid as a growth regulator have complementary effects on fruit characteristics in terms of fruit weight and fruit oil %. Also, induced reduction in fruit drop and 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.

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

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

Treatment		Weight of fruit (gm)		Volume of fruit (cm^3)	
		2013	2014	2013	2014
Control (without spray 0%)		4.61 d	4.70 d	4.50 c	4.57 c
B.B	0.25 %	6.07 abc	6.39 abc	5.89 a	6.20 ab
	0.5 %	5.13 cd	5.68 cd	5.02 bc	5.51 bc
F.B	0.25 %	5.81 bc	6.09 bc	5.04 bc	5.87 ab
	0.5 %	6.31 a	7.25 a	6.25 a	6.67 a
B.B +	0.25 %	5.10 cd	5.65 cd	5.78 ab	5.65 ab
F.B	0.5 %	6.22 ab	6.80 ab	5.86 a	6.50 ab
Means of	B.B	5.27 A	5.59 A	5.14 A	5.42 A
	F.B	5.58 A	6.01 A	5.26 A	5.50 A
	B.B + F.B	5.31 A	5.72 A	5.38 A	5.57 A
Means of	0 %	4.61 B	4.70 B	4.50 B	4.57 B
	0.25 %	5.45 A	6.04 A	5.57 A	5.91 A
	0.5 %	5.89 A	6.58 A	5.71 A	6.02 A

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

B.B = before blooming, F.B. = after blooming

Table 4. Effect of foliar application of zinc sulphat and Gibbralic acid on f Pulp / Pit ratio and shape index (length\diameter ratio) of olive trees Manzanillo cv.

Treatment		Pulp / Pit ratio		shape index	
		2013	2014	2013	2014
Control (without spray 0%)		4.57 c	3.17 c	1.25 a	1.22 a
B.B	0.25 %	5.66 ab	3.81 bc	1.29 a	1.30 a
	0.5 %	5.29 bc	3.83 bc	1.29 a	1.31 a
F.B	0.25 %	5.14 bc	4.61 ab	1.27 a	1.24 a
	0.5 %	4.97 bc	4.74 ab	1.28 a	1.29 a
B.B + F.B	0.25 %	5.06 bc	4.79 ab	1.31 a	1.32 a
	0.5 %	6.44 a	5.07 a	1.27 a	1.26 a
Means of	B.B	5.17 A	3.60 A	1.28 A	1.28 A
	F.B	4.89 A	4.17 A	1.27 A	1.25 A
	B.B + F.B	5.35 A	3.34 A	1.28 A	1.27 A
				1.25 B	1.22 A

Means of	0 %	4.57 B	3.17 B		
	0.25 %	5.28 A	4.40 A	1.29 A	1.29 A
	0.5 %	5.56 A	4.55 A	1.28 AB	1.29 A

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

B.B = before blooming, F.B. = after blooming

Table 5. Effect of foliar application of zinc sulphat and Gibbralic acid on Acidity and Moisture percentage of olive trees Manzanillo cv.

Treatment		Acidity %		Moisture %	
		2013	2014	2013	2014
Control (without spray 0%)		1.18 a	1.68 a	62.67 a	63.01 a
B.B	0.25 %	1.02 ab	1.49 bc	61.32 abc	62.05 ab
	0.5 %	0.77 c	0.91 d	60.09 bc	61.10 b
F.B	0.25 %	1.02 ab	1.52 bc	61.73 ab	62.54 a
	0.5 %	0.92 bc	1.37 c	57.47 d	60.26 bc
B.B +	0.25 %	1.13 a	1.62 ab	60.18 bc	60.37 b
F.B	0.5 %	1.01 ab	1.55 ab	59.75 c	59.38 c
Means of	B.B	0.99 A	1.36 B	61.36 A	62.05 A
	F.B	1.04 A	1.52 AB	60.62 A	61.94 A
	B.B + F.B	1.11 A	1.62 A	60.87 A	60.92 A
Means of	0 %	1.18 A	1.68 A	62.67 A	63.01 A
	0.25 %	1.06 AB	1.54 A	61.08 AB	61.65 AB
	0.5 %	0.90 B	1.28 B	59.10 B	60.25 B

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

B.B = before blooming, F.B. = after blooming

Table 6. Effect of foliar application of zinc sulphat and Gibbralic acid on fruit Oil % of olive trees Manzanillo cv.

Treatment		Oil % dry weight		Oil % fresh weight	
		2013	2014	2013	2014
Control (without spray 0%)		31.33 c	30.05 c	11.70 c	11.12 c
B.B	0.25 %	36.30 b	34.79 b	14.04 b	13.20 b
	0.5 %	40.63 a	37.87 a	16.22 a	14.73 a
F.B	0.25 %	34.87 b	34.67 b	13.34 b	12.99 b
	0.5 %	38.27 ab	37.80 a	16.28 a	15.02 a
B.B +	0.25 %	34.73 b	34.14 b	13.83 b	13.52 b
F.B	0.5 %	38.35 ab	37.27 a	15.44 a	15.14 a
				13.99 A	13.02 A
Means of	B.B	36.09 A	34.24 A		
	F.B	34.82 A	34.17 A	13.77 A	13.04 A
	B.B + F.B	34.80 A	33.82 A	13.66 A	13.26 A
				11.7 C	11.12 C
Means of	0 %	31.33 C	30.05 C		
	0.25 %	35.30 B	34.53 B	13.74 B	13.24 B
	0.5 %	39.08 A	37.31 A	15.98 A	14.96 A

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

B.B = before blooming, F.B. = after blooming

Table 7. Effect of foliar application of zinc sulphat and Gibbralic acid on Yield of tree (kg) of olive trees Manzanillo cv.

Treatment		Yield of tree (kg)	
		2013	2014
Control (without spray 0%)		31.50 c	37.50 c
B.B	0.25 %	48.33 ab	50.13 ab
	0.5 %	47.67 ab	58.08 a
F.B	0.25 %	44.28 bc	41.50 bc
	0.5 %	58.33 a	59.45 a
B.B + F.B	0.25 %	40.85 c	42.89 bc
	0.5 %	50.01 ab	53.65 a
Means of	B.B	42.50 A	48.57 A
	F.B	44.70 A	42.82 A
	B.B + F.B	40.79 A	44.68 A

Means of	0 %	31.50 C	37.50 C
	0.25 %	44.94 B	44.84 B
	0.5 %	52.00 A	53.65 A

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

B.B = before blooming , F.B. = after blooming

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