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Improving Growth and Productivity of Olive Trees through Raising Photosynthesis Efficiency.

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ABSTRACT

The application of magnesium sulphate at the rate of 100g/tree in each of January, April, June and August increased significantly vegetative growth, photosynthetic pigments, leaf mineral contents (N, P, K and Mg), carbohydrates content in leaves, flowering characteristics (density, perfect flowers %, initial and final fruit set), fruit quality (weight, size, diameter and pulp/seed ratio. Oil content in fruit was increased (18-20 %) in comparison with (12 %) in untreated trees. Yield of treated trees with magnesium sulphate was doubled (43 kg/tree) in comparison with (20 Kg/ tree) in untreated trees. The increase of growth and productivity of Manzanillo olive trees treated with magnesium sulphate could be explained by improving photosynthesis efficiency.

Keywords: Olive, Magnesium sulphate, Growth, Leaf mineral, Carbohydrate, Photosynthetic pigments, Yield, Oil content.

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INTRODUCTION

Magnesium is a major element playing a role in the photosynthesis, when it is deficient, photosynthetic activity is reduced [1]. It is an essential component of the chlorophyll molecule containing 6.7 percent magnesium and has an important role in plants growth and development [2].

On Manzanillo olive trees, [3] sprayed magnesium sulphate four times in April, May, June and July and found that magnesium sulphate significantly increased growth of shoot and leaves. Olive trees treated with magnesium sulfate fertilizer (12-24 g/tree/year) in January increased the level of magnesium and showed significantly increase in the vegetative growth and enhanced flowering density; fruit set and yield [4]. Canino apricot trees sprayed with magnesium sulfate (0.5, 1 and 3%) in February (blooming) and April (fruit setting) significantly increased leaf area, mineral content (N, P, K and Mg) in leaves and improved fruits [5].
The aim of present study is to increase growth and productivity of olive trees by improving photosynthesis efficiency.

MATERIAL AND METHODS

This study was carried out during two successive seasons 2009 and 2010 on ten-years-old Manzanillo olive trees, planted at 5 X 5 m and grown in sandy soil in a private orchard located at Cairo–Alexandria desert road (about 50 Km from Cairo), Egypt. Trees were of normal growth, uniformed in vigour and received the same horticultural practices. This experiment aimed to examine spraying dates with magnesium on the photosynthetic pigments concentration, vegetative growth, flowering, yield, fruit characteristics and oil content. The experiment included four magnesium fertilization treatments with magnesium sulphate (20% MgO) in both seasons 2009 and 2010; the applied treatments involved the following:

Treatments / Date of application	1	2	3	4 (Control)
	Amount of magnesium sulphate (g/tree)			
January	100	-	-	125
February	-	100	-	-
March	-	-	100	-
April	100			125
May	-	100	100	-
June	100	-	-	-
July	-	100	100	125
August	100	-	-	-
September	-	100	100	125

***** Control (recommended dose according to the ministry of Agriculture, Egypt).

The effect of the previous treatments was studied by evaluating influence on the following parameters:-

1. Vegetative growth including leaf area, leaf dry weight and Specific leaf dry weight.
2. Flowering including density, percentage of perfect flowers, initial and final fruit set percentage according to [6].
3. Fruiting including fruit weight, size, length, diameter, shape index and percentage of pulp/seed.
4. Yield as Kg/tree at maturity stage.
5. Chemical analysis including photosynthetic pigments (chlorophyll a, chlorophyll b and total chlorophyll) according to [7], leaf mineral contents (N, P, K and Mg) and total carbohydrates percentage according to [8] and fruit oil content as a dry weight was determined according to [9].

Statistical analysis

The present study followed randomized block design. The obtained data of both seasons (2009 and 2010) were subjected to analysis of variances using (SAS/STAT). Least significant difference (L.S.D) was used to compare between means of treatments according to Snedecor and Cochran [10] at probability of 5%.

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RESULTS AND DISCUSSION

The main objective of this study is to investigate the effect of application of magnesium sulphate on growth and productivity of Manzanillo olive tree.

Vegetative growth

The highest leaf area was obtained with application of magnesium sulphate at the rate of 100g/tree in each of January, April, June and August (3.97 and 3.90cm²). The highest leaf dry weight averaged (2.54 and 2.61g) respectively in the two seasons of the study, while specific leaf weight increased to (639.46 and 671.16 mg/cm²) respectively in the 2009 and 2010 seasons (Table 1). These findings agree with results reported by [3, 4, 11] on olive trees.

The enhanced growth of Manzanillo olive trees as a result to $MgSO_4$ treatment participates in chlorophyll building. The pigments content (chlorophyll a, b) in leaves were enhanced, this may reflect in more photosynthesis. Magnesium acts as an enzyme activator which facilities a wide diversity of reactions, especially in the transfer of energy; these all metabolites are needed for plant growth and development.

Table 1. Effect of fertilization with magnesium sulphate $MgSO_4$ on leaf area, leaf dry weight, specific leaf weight during 2009 and 2010 seasons.

Treat.	Date of application	Leaf area (cm²)		Leaf dry weight (g)		Specific leaf weight (mg/cm²)	
		2009	2010	2009	2010	2009	2010
T1	Jan. 100g	3.85d	3.69 d	2.33d	2.47 c	605.19d	669.38b
	Apr. 100g	3.91c	3.83 c	2.42c	2.47 c	618.93c	644.91d
	June 100g	3.95b	3.86b	2.66b	2.71 b	673.42a	702.07a
	Aug. 100g	4.18a	4.16a	2.76a	2.78a	660.29b	668.27c
Mean		3.97a	3.90a	2.54a	2.61a	639.46a	671.16a
T2	Feb. 100g	3.50c	3.58c	1.89c	1.87c	540.00b	522.35d
	May 100g	3.58b	3.60b	1.92bc	1.90bc	536.31d	527.78c
	July 100g	3.60b	3.60b	1.94b	1.91b	538.89c	530.56b
	Sep. 100g	3.72a	3.66a	2.09a	2.33a	561.83a	636.61a
Mean		3.60b	3.61b	1.96b	2.00b	544.26b	554.32b
T3	Mar. 100g	3.31bc	3.35c	1.79c	1.82ab	540.79c	543.28a
	May 100g	3.33b	3.46b	1.81b	1.83ab	543.54bc	528.9b
	July 100g	3.40ab	3.53ab	1.86a	1.84ab	547.06a	521.25c
	Sep. 100g	3.42a	3.54a	1.86a	1.85a	543.86b	522.59c
Mean		3.37c	3.47c	1.83c	1.84bc	543.81b	529.01c
T4(control)	Jan. 125g	3.06c	3.21c	1.44c	1.30cd	470.59d	404.98c
	Apr. 125g	3.20b	3.27b	1.70b	1.31c	531.25c	400.61c
	July 125g	3.20b	3.27b	1.73ab	1.72ab	540.63a	525.99a
	Sep. 125g	3.25a	3.33a	1.75a	1.74a	538.46b	522.52b
Mean		3.18d	3.27d	1.66d	1.52c	520.23c	463.53d

Means in each column with similar letters are not significantly different at 0.05% of probability.

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Photosynthetic pigments

Chlorophyll (a) and chlorophyll (b) as well as total chlorophyll (a+b) were significantly increased by magnesium sulphate application especially at rate 100g/tree in each of January, April, June and August with averaged (1.93 and 1.96 mg/g), (3.87 and 3.88 mg/g) and (4.24 and 4.18mg/g) respectively in the two seasons of the study (Table 2).

Table 2. Effect of fertilization with magnesium sulphate $MgSO_4$ on photosynthetic pigments during 2009 and 2010 seasons.

Treat.	Date of application	Chlorophyll(a) (mg/g fresh weight of leaf)		Chlorophyll(b) (mg/g fresh weight of leaf)		Total chlorophyll (a+b)(mg/g fresh weight of leaf)	
		2009	2010	2009	2010	2009	2010
T1	Jan. 100g	1.89c	1.89bc	3.84c	3.81c	4.67c	4.61c
	Apr. 100g	1.91bc	1.90b	3.86bc	3.89b	4.73bc	4.62bc
	June 100g	1.93b	1.90b	3.87b	3.89b	4.74b	4.63b
	Aug. 100g	2.00a	2.15a	3.91a	3.92a	4.76a	4.66a
Mean		1.93a	1.96a	3.87a	3.88a	4.73a	4.63a
T2	Feb. 100g	1.67c	1.68c	3.62d	3.55d	4.51bc	4.56b
	May 100g	1.71b	1.72b	3.65c	3.59c	4.52b	4.56b
	July 100g	1.80ab	1.75a	3.73b	3.61b	4.52b	4.58a
	Sep. 100g	1.81a	1.75a	3.76a	3.64a	4.62a	4.58a
Mean		1.75b	1.73b	3.69b	3.60b	4.54b	4.57b
T3	Mar. 100g	1.54cd	1.45c	3.49c	3.45bc	4.43b	4.37c
	May 100g	1.56c	1.52b	3.52bc	3.46b	4.45ab	4.46b
	July 100g	1.60b	1.65ab	3.53b	3.51ab	4.45ab	4.51a
	Sep. 100g	1.66a	1.66a	3.59a	3.50a	4.46a	4.51a
Mean		1.59c	1.57c	3.53c	3.48c	4.45c	4.46c
T4(control)	Jan. 125g	1.41c	1.38c	2.95d	2.94d	4.09c	4.04d
	Apr. 125g	1.42bc	1.43b	2.99c	3.17c	4.27b	4.12c
	July 125g	1.44b	1.43b	3.36b	3.29b	4.29ab	4.23b
	Sep. 125g	1.48a	1.45a	3.41a	3.39a	4.31a	4.34a
Mean		1.44d	1.42d	3.18d	3.20d	4.24d	4.18d

Means in each column with similar letters are not significantly different at 0.05% of probability.

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Leaf mineral contents and total carbohydrates

Phosphorus and potassium contents in the leaves significantly increased with average (0.24 and 0.97 %) respectively. Magnesium content also increased in the second season (0.19%), while nitrogen does not affect. Total carbohydrates content were significantly increased at 100g/tree of magnesium application 70-74 % (Table 3). The obtained results are in agreement with those obtained by [5, 11] who reported that magnesium application at 300 and 700 g/tree) significantly increased leaf mineral content.

Table 3. Effect of fertilization with magnesium sulphate $MgSO_4$ on leaf mineral content and total carbohydrates of Manzanillo olive trees during 2009 and 2010 seasons.

Treatments	N%		P%		K%		Mg %		Total Carbohydrates %	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
T1	1.95a	1.86a	0.19a	0.20ab	0.90a	0.85ab	0.18a	0.19a	74.13a	70.89a
T2	1.94a	1.84a	0.16ab	0.17cb	0.84ab	0.80cb	0.16a	0.17ab	65.10b	63.93b
T3	1.92a	1.84a	0.15ab	0.24a	0.82cb	0.97a	0.15a	0.14cb	58.50cb	55.32c
T4 (Control)	1.89a	1.83a	0.12b	0.15c	0.79c	0.77c	0.15a	0.12c	50.39c	48.70d

Means in each column with similar letters are not significantly different at 0.05% of probability.

Flowering and fruit set

Data presented in Table (4) indicated that flowering density, perfect flowers %, initial and final fruit set percentage were significantly by magnesium application specially at 100g/tree of magnesium sulphate in each of January, April, June and August recording flowering density (16-17 /m), perfect flowers (81-84%), initial fruit set (8-9%) and final fruit set (4-5 %). These results are agreement with [4, 11] who reported that magnesium sulfate application significantly enhanced the flowering density, perfect flowers percentage, initial and final fruit set.

Table 4. Effect of fertilization with magnesium sulphate $MgSO_4$ on flowering characteristics during 2009 and 2010 seasons.

Treatments	Flowering density (number of inflorescences/m)		Perfect flowers (%)		Initial fruit set (%)		Final fruit set(%)	
	2009	2010	2009	2010	2009	2010	2009	2010
T1	16.66a	17.66a	84.39a	81.57a	9.14a	8.38a	5.09a	4.79a
T2	14.66a	13.33b	74.43b	70.99b	8.15a	7.33ab	4.82ab	4.26ab
T3	7.66b	5.33c	53.14c	52.87c	7.03b	6.75ab	3.41cb	4.05ab
T4(Control)	6.00b	8.00c	52.77c	51.16c	5.51c	4.74b	3.17c	2.24b

Means in each column with similar letters are not significantly different at 0.05% of probability.

Fruit quality and yield

The obtained data Table (5,6) indicated that the highest fruit weight (5.8-6.09 g), fruit size (5.5-5.7cm^3), fruit diameter(1.86-1.87cm), fruit shape index (1.32-1.44), pulp/seed ratio (78-80 %), fruit moisture content (71-74.33 %), oil content (18-20 %) and yield (43 kg/tree) were obtained by magnesium application at the rate of 100g /tree in each of January, April, June and August in comparison with (12 %) oil content and 20 Kg/ tree for yield in untreated trees.

The improving of fruit quality might be attributed to the importance of magnesium as an integral part in the composition of the main plant pigment; chlorophyll which is essential to perform the photosynthesis process. It plays an important role in normal metabolic pathway in plant cell. Moreover, the timing of magnesium salphate application was effective in enhancing the vegetative growth characteristics, flowering

and fruit set. This was reflected on increasing yield. The above mentioned results are in harmony with [3, 4, 11].

Table 5. Effect of fertilization with magnesium sulphate $MgSO_4$ on fruit quality of Manzanillo olive trees during 2009 and 2010 seasons.

Treatments	Fruit weight (g)		Fruit size (cm^3)		Fruit length (cm)		Fruit diameter (cm)		Fruit shape L/D		Pulp/seed ratio	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
T1	6.00a	5.83a	5.50a	5.73a	2.46a	2.70a	1.86a	1.87a	1.32a	1.44a	80.23a	78.83a
T2	5.69b	5.82a	5.03b	5.46a	2.20b	2.16b	1.76ab	1.83a	1.24ab	1.18b	74.93b	77.00ab
T3	5.31c	5.06b	4.80c	4.66b	1.80c	1.70c	1.66b	1.53b	1.08cb	1.10b	71.46c	70.33cb
T4(Control)	4.96d	4.99b	4.16d	4.36b	1.56c	1.26d	1.53c	1.46b	1.02c	0.86c	67.30d	64.66c

Means in each column with similar letters are not significantly different at 0.05% of probability.

Table 6. Effect of fertilization with magnesium sulphate $MgSO_4$ on yield, fruit moisture and oil content of Manzanillo olive trees during 2009 and 2010 seasons.

Treatments	Yield (Kg/ tree)			Fruit moisture content (%)		Oil content (%)	
	2009	2010	Mean	2009	2010	2009	2010
T1	39.33a	47.00a	43.17a	71.43a	74.33a	18.13a	20.51a
T2	38.16ab	36.33b	37.25b	69.13a	72.33ab	16.66a	17.86ab
T3	27.66cb	25.66c	26.66c	64.20b	68.66ab	15.66ab	14.47cb
T4(Control)	21.00c	18.99d	20.00d	60.30c	68.33b	12.66b	12.69c

Means in each column with similar letters are not significantly different at 0.05% of probability.

CONCLUSION

From the obtained results it could be recommended that spraying magnesium sulphate at 100g/tree in each of January, April, June and August improve photosynthesis efficiency and increase growth and productivity of olive trees.

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