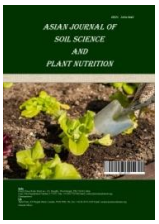

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Productivity and Fruit Quality of Manzanello and Picual Olive (*Olea europaea* L.) Cultivars as Influenced by Spraying Lithovit under Different Irrigation Levels

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Olive tree is the favorable choice to cultivate in desert lands due to high stress tolerance of its tree. Although olive tree tolerates the low availability of water in the soil by means of morphological, physiological and biochemical adaptations, the Productivity and fruit quality of it decrease gradually with increasing water stress. So we have initiated this study to follow up the effect of spraying Lithovit (Ca CO_3 & Mg CO_3) on the productivity and fruit quality of Picual and Manzanello olives which exposure to different irrigation levels. Four concentrations of Lithovit were sprayed on olive (*Olea europaea* var. Manzanello) trees (0, 2, 4 and 6 g/L) under three irrigation levels (50, 75 and 100% of evapotranspiration for crop "ETc") during 2017, 2018 seasons.

Spraying Lithovit at 6 g/L recorded the highest values of all fruit physical characteristics of both cultivars in the two seasons. Furthermore, 2 g/L had the highest values of retained fruit percentage of both cultivars which led to increase the yield in the first and second seasons. Concerning irrigation levels, the values of fruit physical characteristics of both cultivars were the lowest values with applying 50% of ETc irrigation level. These values increased with decreasing water stress in

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the first and second seasons. Concerning retained fruit percentage and yield of Picual and Manzanello, the most promising level of irrigation was 75% of ETc level because it recorded the highest values of yield. Moreover 100% of ETc enhanced the fruit quality.

Keywords: Olive; Picual; Manzanello; Lithovit®; fertilizer, water stress.

1. INTRODUCTION

Olives are woody species typically cultivated in most Mediterranean countries. Olive tree is a strategic tree, which grow in reclaimed areas, whereas planting the other crops in these areas is economically feasible. In addition to the economic importance of olive fruit and olive oil production, olives have natural and medical uses [1]. Moreover olive tree can resist abiotic potentials such as drought, fluctuation in temperature, salinity, drought, etc [1,2].

Previous studies indicated that water stress plays a major role in olives growth and productivity moreover; it impairs the performance of olives growth and production. Besides vegetative growth, flowering productivity and fruit quality of olives decrease gradually with increasing water stress on the other hand supplying olives with water requirements increase vegetative growth, flowering and yield quantity and quality [1,3,4,5,6].

Spraying Lithovit® fertilizer is natural stone which grinded in special mills and converted to fine powder" as foliar application leads to decompose its particles and release among other substances, especially calcium oxide (Ca O) and carbon di oxide (CO_2) at high concentration in the intercellular compartment inside the leaves as well as on leaves surface which penetrate directly through the stomata [7]. The process of elevate CO_2 in intercellular compartment and on leave surface lead to close stomata and photosynthesis continue efficiently due to diffused carbon dioxide inside the leaves, so plant decrease transpiration rate and reduce water requirement due to high drought tolerance [8,9,10]. This study was initiated to follow up the effect of spraying Lithovit ($CaCO_3$ & $MgCO_3$) on the productivity and fruit quality of Picual and Manzanello olives which exposure to different irrigation levels.

2. MATERIALS AND METHODS

This study was carried out at Wadi El-Natron in a sandy soil “Surface soil samples were taken and air dried for carrying out physical and chemical analysis which presented in the Tables 1 and 2” of a private orchard at Wadi El-Natron, El Behera governorate, Egypt (30° 31' 05" N and 30° 07' 34" E). The experiment was started in December and continued during two successive growing seasons (2017& 2018). It was investigated on Manzanello olive cultivar. Seventy-two bearing trees were selected and divided into 12 different treatments. Each treatment divided into three replicates and two trees for each of them. These selected trees were treated with three irrigation levels (50, 75 and 100% of ETc) and four concentrations of Lithovit® fertilizer” (0, 2, 4 and 6 g/L) were sprayed as a foliar application in the first week of February, May, and August.

The following table presented chemical analysis of irrigation water sample, which taken from a well after two hours of starting operating.

2.1 Climatic Data

Meteorological data were investigated before conducting the experiments by using climwatt and cropwatt programs to calculate reference evapotranspiration and showed in Tables 4 and 5.

ETc calculated as follow:

ETc = ETo × Kc

ETc: crop evapotranspiration

ETo: reference crop evapotranspiration

Kc: crop coefficient

2.2 Data of Following Parameters Were Recorded: Fruit Physical Characteristics and Yield

Fruit physical characteristics and yield were determined at first week of Sebtember for Manzanello and third week of Sebtember for Picual olives.

Fruit, stone and flesh weight: Fruit, stone and flesh weight were measured by using a balance for 20 fruits per tree.

Fruit dimensions: The average of longitudinal and equatorial fruit diameters of 20 fruits per tree were measured by using a Verner Caliper.

Table 1. Analysis of mechanical dry sieving of the orchard experimental soil

Texture	Depth	1-2 mm	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt + clay
Sandy soil	0-60 cm	7.5191	15.3507	38.1163	32.182	6.4756	0.3563

Table 2. chemical analysis of the orchard experimental soil

Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	$SO4^{--}$	PH	EC	TDS
meq/ L								7.6	dS/m	mg/L
25.988	2.518	5.218	0.383	Nil	0.42	30.389	4.828		3.34	2333.4

Table 3. Analysis of irrigation water simple

EC	TDS	PH	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	SO_4^{--}	Cl^{-}
µS/cm	Mg/l	7.7	Cations	meq/l			Anions	meq/l		
1617	641.5		1.638	1.467	8.696	0.077	0.799	2.599	0.262	7.668

Table 4. Meteorological data and ETo. in El Behera governorate

Month	Min temp.	Max temp.	Humidity	Wind	Sun	Rad	Eff. rain	ETo
	°C	°C	%	km/day	hours	MJ/m²/day	mm	mm/day
Jan.	5.2	19.8	52	207	7.8	13.9	1	2.86
Feb.	6.6	21.8	44	242	8.6	17.1	1	3.89
Mar.	9.6	24.8	39	277	8.9	20.1	1	5.19
Apr.	13.8	30.7	31	277	9.3	22.8	1	6.95
May	17.5	34.5	29	268	10.3	25.3	0	8.05
June	20.3	36.9	31	277	11.2	26.9	0	8.84
July	21.3	37.1	36	225	11.1	26.5	0	8.01
Aug.	21.4	36.8	38	207	10.8	25.3	0	7.48
Sep.	19.4	34.4	43	216	9.9	22.1	0	6.50
Oct.	16.2	30.3	46	216	9.1	18.3	0	5.15
Nov.	10.6	25.5	51	181	8.4	14.9	0	3.55
Dec.	6.6	20.7	55	199	7.9	13.3	0	2.79

Table 5. Kc and ETc. in El-Behara, by using climwatt and cropwatt programs and FAO 56

	Kc 1	Kc 2	ETc 1 mm/day	ETc 2 mm/day
January	0.50	0.50	1.43	1.43
February	0.50	0.50	1.945	1.945
March	0.65	0.65	3.3735	3.3735
April	0.68	0.60	4.69125	4.17
May	0.68	0.55	5.43375	4.4275
June	0.68	0.50	5.967	4.42
July	0.70	0.45	5.607	3.6045
August	0.70	0.45	5.236	3.366
September	0.70	0.45	4.55	2.925
October	0.70	0.65	3.605	3.3475
November	0.70	0.65	2.485	2.3075
December	0.70	0.65	1.953	1.8135

Retained fruit percentage (RF %): Number of retained fruits of normal size at harvest was determined and HFS was calculated according the next equation.

$$\text{RF } \% = \frac{\text{Number of fruits at harvest}}{\text{Number of initial fruits}} \times 100$$

Fruit yield: It recorded as Kg/ tree by using a digital balance.

2.3 Statistical Analysis

Results of this study were exposed to proper statistical analysis of variance for a split plot design with two factors "irrigation treatments were allocated as main plot and spraying Lithovit as sub plot" using statistix computer program [11] with three replicates. Each replicate's value was the average of two trees values. Duncan's multiple range tests were used to compare between means. Alphabetical letters in the column are significantly different at (0.05) level [12]. The same trees were used throughout both of experimental seasons.

3. RESULTS AND DISSCUSSION

3.1 Fruit Physical Characteristics and Yield

Fruit weight: Data presented in Tables (7 &8) illustrate that, significant effects were observed on fruit weight values of Manzanello and Picual olive cultivars due to different treatments in both seasons.

Spraying with Lithovit at 6 g/L concentration gave the highest values of fruit weight of Manzanello (5.76 & 6.53 g) and Picual (6.50 & 6.81 g) olive cultivars compared with the other treatments in the first and second seasons, respectively. Besides, 100% of ETc irrigation significantly increased fruit weight of Manzanello (5.84 & 6.48 g) and Picual (6.32 & 6.74 g) olive cultivars compared with the other treatments in the first and second seasons, respectively.

The interaction between irrigation levels and Lithovit showed that the highest fruit weight values were recorded with 100% of ETc irrigation and spraying Lithovit at 6 g/L on Manzanello (6.90 & 7.93 g) and Picual (7.84 & 8.13 g) olive cultivars compared with the other treatments in the first and second seasons, respectively.

Seed weight: Data presented in Tables (7 & 8) indicate that, seed weight of Manzanello and Picual olive cultivars was significantly affected with all treatments in both seasons.

Spraying Lithovit at 6 g/L increased seed weight of Manzanello (0.98 & 1.01 g) and Picual (1.11 & 1.24 g) olive cultivars compared with the other treatments in the first and second seasons, respectively. In addition, trees which irrigated with 100% of ETc recorded the highest significant values of Manzanello (0.92 & 1.00 g) and Picual (1.12 & 1.16 g) olive cultivars compared with the other treatments in the first and second seasons, respectively.

Regarding the interaction between irrigation levels and spraying Lithovit, the highest seed weight values were noticed with 100% of ETc irrigation and spraying Lithovit at 6 g/L level of Manzanello (1.02 & 1.07 g) and Picual (1.37 & 1.39 g) olive cultivars compared with the other treatments in the first and second seasons, respectively.

Table 6. Irrigation water quintets, dates and intervals in El-Behera governorate

Month	First season			Second season		
	Irrigation requirement	Irrigation duration	Irrigation interval	Irrigation requirement	Irrigation duration	Irrigation interval
	L/ day	hours/ day	dayes	L/ day	hours/ day	dayes
January	23.32	0.25	9	23.32	0.25	9
February	31.72	0.34	6	31.72	0.34	6
March	55.02	0.60	4	55.02	0.60	4
April	76.51	0.83	3	68.00	0.74	3
May	88.61	0.96	2	72.20	0.78	3
June	97.31	1.06	2	72.08	0.78	3
July	91.44	0.99	2	58.78	0.64	3
August	85.39	0.93	2	54.89	0.60	4
September	74.20	0.81	3	47.70	0.52	4
October	58.79	0.64	3	54.59	0.59	4
November	40.53	0.44	5	37.63	0.41	5
December	31.85	0.35	6	29.57	0.32	7

Flesh weight: Data in Tables 7 & 8 indicate that, flesh weight of Manzanello and Picual olive cultivars were significantly varied in response to all treatments in both seasons.

Spraying with Lithovit at 6 g/L concentration recorded the highest flesh weight values of Manzanello (4.79 & 5.52 g) and Picual (5.40 & 5.57 g) olive cultivars compared with the other treatments in the first and second seasons, respectively. Similarly, irrigation with 100% of ETc significantly increased flesh weight values of Manzanello (4.89 & 5.44 g) and Picual (5.20 & 5.59 g) olive cultivars compared with the other treatments in the first and second seasons, respectively.

The interaction between irrigation levels and Lithovit spray concentrations showed that spraying with Lithovit at 6 g/L concentration and 100% of ETc irrigation recorded the highest flesh weight values of Manzanello (5.88 & 6.83 g) and Picual (6.47 & 6.75 g) olive cultivars compared with the other treatments in the first and second seasons, respectively.

Longitudinal fruit diameter: Longitudinal fruit diameter values significantly responded to different treatments in both seasons as shown in Tables (9 & 10).

Data observed that spraying with Lithovit at 6 g/L recorded the highest values of longitudinal fruit diameter of Manzanello (19.56 & 23.80 mm) and Picual (26.74 & 28.79 mm) olive cultivars compared with the other treatments in the first and second seasons, respectively. Similarly, irrigation with 100% of ETc recorded the highest values of longitudinal fruit diameter of Manzanello (19.62 & 23.69 mm) and Picual (27.78 & 28.51 mm) olive cultivars compared with the other treatments in the first and second seasons, respectively.

Concerning the interaction between irrigation and spraying Lithovit, the highest values of

Table 7. Effect of spraying Lithovit and irrigation levels on fruit weight, seed and flesh weight of Manzanello olives during 2017 and 2018 seasons

Treatments			2017					2018				
			Lithovit rate (g/L)				Mean	Lithovit rate (g/L)				Mean
			0 g/L	2 g/L	4 g/L	6 g/L		0 g/L	2 g/L	4 g/L	6 g/L	
Fruit weight (g)	Irrigation levels	100%	5.04 c	5.62 b	5.71 b	6.90 a	5.82 A	5.07 f	5.87 d	6.86 b	7.93 a	6.48 A
		75%	4.35 d	4.87 c	5.72 b	6.02 b	5.24 B	4.57 g	4.97 fg	5.77 de	6.40 c	5.43 B
		50%	2.38 f	3.71 e	4.07 de	4.37 d	3.63 C	4.00 h	4.17 h	4.47 g	5.27 e	4.48 C
	Mean		3.92 D	4.73 C	5.17 B	5.76 A		4.54 D	5.00 C	5.70 B	6.53 A	
Seed weight (g)	Irrigation levels	100%	0.81 g	0.90 e	0.95 c	1.02 a	0.92 A	0.96 bc	0.98 bc	0.98 bc	1.07 a	1.00 A
		75%	0.72 i	0.73 i	0.86 f	0.98 b	0.82 B	0.85 ef	0.94 de	1.01 cd	0.96 bc	0.92 B
		50%	0.65 j	0.72 i	0.77 h	0.92 d	0.77 C	0.75 g	0.80 fg	0.85 ef	0.94 cd	0.84 C
	Mean		0.73 D	0.78 C	0.86 B	0.98 A		0.85 C	0.89 B	0.92 B	1.01 A	
Flesh weight (g)	Irrigation levels	100%	4.23 cd	4.71 bc	4.76 b	5.88 a	4.89 A	4.14 f	4.89 d	5.88 b	6.83 a	5.44 A
		75%	3.63 ef	4.14 de	4.86 b	5.03 bf	4.41 B	3.70 h	4.09 h	4.84 g	5.39 e	4.51 B
		50%	1.73 h	2.99 g	3.30 fg	3.45 fg	2.87 C	23.25 g	3.37 f	3.59 d	4.32 c	3.63 C
	Mean		3.20 D	3.95 C	4.30 B	4.79 A		3.70 D	4.12 C	4.77 B	5.52 A	

Means followed by the same letters (S) in each row, column or interaction are not significantly different at 5% level

longitudinal fruit diameter were recorded with 100% of ETc irrigation levels and spraying Lithovit at 6 g/L concentration on Manzanello (20.80 & 25.80 mm) and Picual (30.07 & 30.97 mm) olive cultivars compared with the other treatments in the first and second seasons, respectively.

Equatorial fruit diameter: Means of equatorial fruit diameter of Manzanillo olives significantly responded to different treatments in the first and the second seasons as presented data in Tables (9 & 10).

Data observed that spraying Lithovit at 6 g/L recorded the highest values of equatorial fruit diameter of Manzanello (1.78 & 2.18 cm) and Picual (2.05 & 2.54 cm) olive cultivars compared with the other treatments in the first and second seasons, respectively.

Furthermore, irrigation with 100% of ETc recorded the highest values of Equatorial fruit diameter of Manzanello (2.02 & 2.30 cm) and Picual (2.06 & 2.45 cm) olive cultivars compared with the other treatments in the first and second seasons, respectively.

Concerning interaction between irrigation and spraying Lithovit, the highest values of Equatorial fruit diameter were recorded with 100% of ETc irrigation levels and spraying Lithovit at 6 g/L concentration on Manzanello (2.14 & 2.46 cm) and Picual (2.16 & 2.86 cm) olive cultivars compared with the other treatments in the first and second seasons, respectively.

Retained fruit percentage: The values of retained fruit percentage were significantly responded to all treatments in both seasons as shown in Tables (11 & 12).

Data observed that spraying Lithovit at 2 g/L recorded the highest values of retained fruit percentage of Manzanello (65.04 & 81.4) and spraying Lithovit at 4 & 2 g/L concentration on Picual olives recorded the highest values of retained fruit percentage (55.68 & 65.98) in the first and second seasons, respectively.

Table 8. Effect of spraying Lithovit and irrigation levels on fruit weight, seed and flesh weight of Picual olives during 2017 and 2018 seasons

Treatments			2017					2018				
			Lithovit rate (g/L)				Mean	Lithovit rate (g/L)				Mean
			0 g/L	2 g/L	4 g/L	6 g/L		0 g/L	2 g/L	4 g/L	6 g/L	
Fruit weight (g)	Irrigation levels	100%	5.03 f	5.83 c	6.54 b	7.84 a	6.32 A	5.47 g	5.47 d	6.90 b	8.13 a	6.74 A
		75%	5.25 e	5.51 d	6.03 c	6.62 b	5.85 B	5.67 h	5.80 g	6.53 g	6.67 f	6.17 B
		50%	3.67 i	4.18 h	4.63 g	5.05 f	4.38 D	4.77 ef	5.33 e	5.37 cd	5.63 c	5.28 C
	Mean		4.65 D	5.18 C	5.73 B	6.50 A		5.30 D	5.87 C	6.27 B	6.81 A	
Seed weight (g)	Irrigation levels	100%	0.90 h	1.06 c	1.14 b	1.37 a	1.12 A	0.97 e	1.13 c	1.15 bc	1.39 a	1.16 A
		75%	0.86 i	0.91 gh	0.93 fg	0.94 ef	0.91 B	0.99 f	1.04 de	1.11 de	1.19 bc	1.08 B
		50%	0.81 j	0.86 i	0.96 e	1.01 d	0.91 B	0.87 e	0.99 d	1.01 c	1.15 b	1.01 C
	Mean		0.86 D	0.95 C	1.01 B	1.11 A		0.94 D	1.05 C	1.09 B	1.24 A	
Flesh weight (g)	Irrigation levels	100%	4.12 h	4.79 e	5.40 c	6.47 a	5.20 A	4.51 f	5.35 d	5.77 b	6.75 a	5.59 A
		75%	4.38 g	4.60 f	5.10 d	5.68 bc	4.94 B	4.68 h	4.75 g	5.40 fg	5.50 fg	5.08 B
		50%	2.86 k	3.32 j	3.67 i	4.04 h	3.47 C	3.89 e	4.36 e	4.36 cd	4.46 c	4.27 C
	Mean		3.79 D	4.24 C	4.72 B	5.40 A		4.36 D	4.82 C	5.18 B	5.57 A	

Means followed by the same letters (S) in each row, column or interaction are not significantly different at 5% level

Table (9) Effect of spraying Lithovit and irrigation levels on longitudinal and equatorial fruit diameter of Manzanello olives during 2017 and 2018 seasons

Treatments			2017					2018				
			Lithovit rate (g/L)				Mean	Lithovit rate (g/L)				Mean
			0 g/L	2 g/L	4 g/L	6 g/L		0 g/L	2 g/L	4 g/L	6 g/L	
Longitudinal fruit diameter (mm)	Irrigation levels	100%	18.73 b-e	19.00 b-d	19.93 ab	20.80 a	19.62 A	21.90 b-d	22.90 a-c	24.17 ab	25.80 a	23.69 A
		75%	17.35 ef	19.20 bc	19.27 b	20.07 ab	18.97 B	20.93 cd	21.33 cd	22.60 b-d	23.07 a-c	21.98 B
		50%	12.97 gh	16.60 f	17.70 d-f	17.80 c-f	16.27 C	19.57 d	20.87 cd	22.40 b-d	22.54 b-d	22.34 B
	Mean		16.35 C	18.27 B	18.97 AB	19.56 A		20.80 C	21.70 BC	23.06 AB	23.80 A	
Equatorial fruit diameter (cm)	Irrigation levels	100%	1.92 b	2.01 ab	2.02 ab	2.14 a	2.02 A	2.05 c	2.25 b	2.45 a	2.46 a	2.30 A
		75%	1.44 e	1.46 e	1.60 d	1.74 c	1.56 B	1.91 de	1.97 cd	2.05 c	2.15 b	2.02 B
		50%	1.04 f	1.35 e	1.42 e	1.46 e	13.16 C	1.84 e	1.84 e	1.92 de	1.93 d	1.88 C
	Mean		1.47 D	1.60 C	1.68 B	1.78 A		1.93 C	2.02 B	2.14 A	2.18 A	

Means followed by the same letters (S) in each row, column or interaction are not significantly different at 5% level

Table 10. Effect of spraying Lithovit and irrigation levels on longitudinal and equatorial fruit diameter of Picual olives during 2017 and 2018 seasons

Treatments		2017					2018				
		Lithovit rate (g/L)				Mean	Lithovit rate (g/L)				Mean
		0 g/L	2 g/L	4 g/L	6 g/L		0 g/L	2 g/L	4 g/L	6 g/L	
Longitudinal diameter (mm)	100%	25.13 cd	27.60 b	28.33 b	30.07 a	27.78 A	25.87 ef	28.01 cd	29.20 b	30.97 a	28.51 A
Irrigation levels	75%	22.87 f	23.80 d-f	24.10 de	25.67 c	24.11 B	24.97 f-h	26.10 ef	27.80 d	29.07 bc	26.98 B
	50%	20.07 g	22.50 f	23.27 ef	24.50 cd	22.58 C	23.80 h	24.47 gh	25.13 fg	26.33 e	24.93 C
Mean		22.69 D	22.63 C	25.23 B	26.74 A		24.88 D	26.19 C	27.38 B	28.79 A	
Equatorial fruit diameter (cm)	100%	1.91 de	2.02 b-d	2.13 ab	2.16 a	2.06 A	2.17 e	2.25 d	2.53 c	2.86 a	2.45 A
Irrigation levels	75%	1.86 ef	1.95 c-e	2.03 bc	2.03 bc	1.97 B	1.99 f	2.18 de	2.46 c	2.63 b	2.31 B
	50%	1.78 f	1.89 ef	1.95 c-e	1.95 c-e	1.89 C	1.88 g	2.01 f	2.10 e	2.12 e	2.03 C
Mean		1.85 C	1.95 B	2.04 A	2.05 A		2.01 D	2.15 C	2.36 B	2.54 A	

Means followed by the same letters (S) in each row, column or interaction are not significantly different at 5% level

Furthermore, irrigation at 75% of ETc recorded the highest values of retained fruit percentage of Manzanello (71.08 & 75.33) and Picual (67.05 & 73.02) olive cultivars compared with the other treatments in the first and second seasons, respectively.

Concerning the interaction between irrigation and spraying Lithovit, the highest values of retained fruit percentage were recorded with 75% of ETc irrigation and spraying Lithovit at 2 g/L of Manzanello (83 & 90.43) and Picual (71.33 & 77.50) olive cultivars compared with the other treatments in the first and second seasons, respectively.

Fruit yield (Kg / tree): As shown in Tables (11 & 12) spraying Lithovit at 4 & 2 g/L concentration significantly increased fruit yield of Manzanello (55.11 & 32.23 Kg/tree) and Picual (46.00 & 30.54 kg/tree)olive cultivars compared with the other treatments in the first and second seasons, respectively also, 75% of ETc irrigation achieved the highest fruit yield of Manzanello (70.04 & 39.81 Kg/tree) and Picual (60.13 & 36.14 kg/tree) olive cultivars compared with the other treatments in the first and second seasons, respectively.

It's obvious that spraying Lithovit at 4 & 2 g/L concentrations with 75% of ETc irrigation level had the maximum fruit yield of Manzanello (75.33 & 45.43 kg/tree) and Picual (65.17 & 40.60 kg/tree) olive cultivars compared with the other treatments in the first and second seasons, respectively.

Spraying Lithovit at 6 g/L recorded the highest values of all fruit physical characteristics of both cultivars in the first and second seasons it might because of the decreasement of yield and the enhancement of water relations. 2 g/L had the highest values of blooming parameters and retained fruit percentage of both cultivars which led to increase the yield in the first and second seasons. In addition, Lithovit application, significantly enhanced olives yield. This effect could be related to the influence of Lithovit, as a source of calcium and CO_2 reservoir. These results are in agreement with those of [13,14,15,16,17].

About irrigation levels, the values of fruit physical characteristics of both cultivars were the lowest values with applying 50% of ETc irrigation level. These values increased gradually with decreasing water stress in the first and second seasons. Concerning retained fruit percentage and yield of Picual and Manzanello, the most promising level of irrigation was 75% of ETc level.

Table 11. Effect of spraying lithovit and irrigation levels on retained fruit percentage and fruit yield/ tree of Manzanello olives during 2017 and 2018 seasons

Treatments			2017					2018				
			Lithovit rate (g/L)				Mean	Lithovit rate (g/L)				Mean
			0 g/L	2 g/L	4 g/L	6 g/L		0 g/L	2 g/L	4 g/L	6 g/L	
Retained fruit (%)	Irrigation levels	100%	51.87 f	64.61 c	62.68 de	62.66 de	60.45 B	63.43 g	85.83 b	79.13 c	67.57 f	51.87 B
		75%	75.33 b	83.00 a	64.33 cd	61.66 e	71.08 A	86.07 b	90.43 a	72.17 e	65.32 g	75.33 A
		50%	44.13 h	47.52 g	44.82 h	42.23 i	44.67 C	76.27 d	67.93 f	70.52 ef	63.51 g	44.13 C
	Mean		57.11 B	65.04 A	57.27 B	55.52 C		75.26 B	81.40 A	73.94 C	66.13 D	
Fruit yield (Kg / tree)	Irrigation levels	100%	54.75 f	61.67 d	76.33 c	56.17 e	59.23 B	27.83 e	33.67 d	37.83 c	33.67 d	33.25 B
		75%	62.83 d	75.17 a	75.33 a	66.83 b	70.04 A	33.87 d	45.43 a	41.60 b	38.33 c	39.81 A
		50%	19.67 i	25.83 g	25.67 g	24.17 h	23.83 C	14.77 f	17.60 f	17.10 f	15.27 f	16.18 C
	Mean		45.75 D	54.22 B	55.11 A	49.06 C		25.49 C	32.23 A	32.18 A	29.09 B	

Means followed by the same letters (S) in each row, column or interaction are not significantly different at 5% level

Table 12. Effect of spraying Lithovit and irrigation levels on retained fruit percentage and fruit yield per tree of Picual olives during 2017 and 2018 seasons

Treatments			2017					2018				
			Lithovit rate (g/L)				Mean	Lithovit rate (g/L)				Mean
			0 g/L	2 g/L	4 g/L	6 g/L		0 g/L	2 g/L	4 g/L	6 g/L	
Retained fruit (%)	Irrigation levels	100%	46.67 g	47.99 fg	49.66 e	50.33 e	48.66 B	61.83 ef	64.30 de	63.80 de	65.63 d	63.89 B
		75%	63.86 c	71.33 a	68.66 b	64.32 c	67.05 A	72.33 b	77.50 a	73.50 b	68.73 c	73.02 A
		50%	55.15 d	47.55 fg	48.72 ef	43.43 h	48.71 B	55.67 f	56.13 f	51.52 g	48.83 g	53.04 C
	Mean		55.22 A	55.62 A	55.68 A	52.70 B		63.28 B	65.98 A	62.94 B	61.07 C	
Fruit yield (Kg/ tree)	Irrigation levels	100%	38.83 h	48.33 f	52.17 e	45.67 g	46.25 B	26.93 f	33.83 c	31.27 d	29.33 e	30.34 B
		75%	54.50 d	62.67 b	65.17 a	58.17 c	60.13 A	31.10 de	40.60 a	38.10 b	34.77 c	36.14 A
		50%	18.00 k	22.33 i	20.67 j	19.83 j	20.21 C	11.10 i	17.20 g	16.27 g	14.17 h	14.68 C
	Mean		37.11 D	44.44 B	46.00 A	41.22 C		23.04 D	30.54 A	25.54 B	26.09 C	

Means followed by the same letters (S) in each row, column or interaction are not significantly different at 5% level

Irrigation at 50% of ETc decreased chlorophyll content, leaf water relations and total carbohydrates and increased proline content of Manzanello and Picual olive cultivars all these led to impair the assimilation process and decreased fruit physical characteristics and yield. It resulted in higher stomatal resistance, decreased photosynthetic efficiency and accentuated fruit drop in olive. Irrigation at 75% of ETc had the highest values of leaf relative water content and total carbohydrates of both cultivars these led to balance between

vegetative, blooming and fruiting growth, while 100% of ETc increased vegetative growth and decreased blooming and fruiting growth of Picual and Manzanello cultivars. These results agree with [18,19,20,21,22].

4. CONCLUSIONS AND RECOMMENDATION

Under the same conditions of the study we recommend that the irrigation at 75% of ETc with spraying Lithovit at 2 g/L on Manzanello and Picual olives it is the best treatment which gave balance between vegetative growth and fruiting aspects. Moreover, we could utilize the variance effect of different irrigation levels and spraying Lithovit concentrations to reduce the hardness of alternative bearing, via spraying 2 g/L of Lithovit and 75% of ETc irrigation level in the off year from one hand. Also, spraying Lithovit at 4 or 6g/L with 100% of ETc irrigation level to improve the aspects of vegetative growth in the on year from the other hand

Finally, we caution against exposing olive trees to severe water stress (50% of ETc).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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