Effect of Using Olive Vegetation Water (OVW) on Growth, Flowering and Yield of Manzanillo Olive Trees

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Abstract: This investigation was carried out during two growing seasons 2009 and 2010 to investigate the effect of using olive oil vegetable water (VW) with farm fertilization on morphological and productive characteristics of *Manzanillo* olive trees grown in a sandy soil under drip irrigation system in a private orchard .A total of four application of the olive oil vegetable water including 0 (control), 24, 48,72 litre /tree were added in the end of canopy shad each two weeks during the period from the first of January till the end of fruit set15th May.Results showed that on applying VW, there was a considerable increase in nitrogen , phosphorus, potassium, calcium, and magnesium content of the soils .Its increased was related to used doses .There was a decrease in sodium , iron and cupper, but chloride was only decreased with VW at 24 &72 litre /tree . With the treatment at 48 litre/ tree, there was a decrease in HCO_3, an increase in organic matter occurred by the application of 24&48 and 72 litre of VW . The highest shoot length was obtained at the rate of 72 litre of VW/tree in the first season, while no difference between other treatments, in the second season. VW at the rate of 72 litre/ tree showed better effects for number of leaves per meter, length of inflorescences , flowering density, percentage of perfect flowers , leaf area in the first season .While there was no difference between treatments with 24 and 48/tree in leaf area in the second season. The results showed that the leaves of control trees gave the highest percentage of leaf nitrogen in the first season, while the trees treated with 24 litre of VW were the best in the second season. There was no considerable increase in P content of the leaves after application in both seasons, treatment with (VW) at72 litre/ tree which gave the highest leaf K , Ca and Mn contents in both seasons and highest leaf Zn content in the first season .The highest Cu leaf content was observed in control treatment .Regarding to flowering behaviour, all the investigated trees bloomed at the same date with no difference between treatments in both studied seasons , except control ;it was earlier 4 days in the first season and 2 days in the second season. The blooming duration was about 11 days in control and 9 days in other treatments in the first season, but the blooming duration in the second season was11 days in all treatments .Treated trees with (48 litter of VW) induced an apparent significant increase in sex expression fruit set , yield, stone weight and percentage of oil in dry weight of Manzanillo trees. The maximum fruit length, diameter , weight ,Flesh weight, Flesh/fruit weight percent and flesh/stone ratio associated with (V W) at 24 litre/tree , and no significance between treatments and control with regard for both stone length and width, while control treatment gave the highest fruit moisture content(%)

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1. Introduction

Olive tree (olea europaea L.) is a species of the family (oleaceae) native to coastal area of Eastern of Mediterranean Basin and spread in many countries on the world. It is considered one of the oldest known cultivated tree in the world,it had a great historic importance. It also constituted the symbol for peace. The fruit of Olive is of a major agricultural importance in the Mediterranean region as a source of Olive oil ,Tous and Romero, (1994). There are aproximately750 million productive Olive trees world wide, which occupy a surface 7 million ha. The annual world wide production of edible oils and Olive oil has been estimated at 8 million and 1.743 million metric tons respectively ,from 25.000 Olive mills ,Rosa et al., (2008).

Spain, Greece , Italy ,Tunisia and Turkey are important Olive oil producers in the Mediterranean Basin ,which represents 97% of the olive oil production in the world ,Akpinar et al.,(2003)

Industrial processes for olive oil production generate a considerable amount of oily waste water, designated "Vegetable water" (VW) and olive pomace. The olive pomace doesn't cause problems because it can be treated to extract its residual oil or it

can be used for fuel. VW particularly, cause serious environmental problems (river and underground water pollution, etc.). In all Mediterranean olive growing countries and their solution represents an environmental challenge upstream and down stream of the olive oil production chain ,Anonymous (1996).

In most olive growing countries, even in the most advanced ones, no definitive answer has been found for the disposal and treatment of this biomass and it is still a major environmental issue, especially in the South and East Mediterranean countries where vast planting and processing modernization schemes are underway to expand and up grade the quality of olive oil produced, IOOC (2008).

VW which is a product from olive oil extraction collected during the late fall and winter season, contains a large amount of both organic and in organic matter that increase the ability of the soil to decompose and break down organic matter and the ability of plant to absorb nutrients from the soil for growth, this led to the application of by products to crop land, Berrin et al., (2008).

VW spreading is regulated under the national laws of the certain olive growing countries in Italy since (1996). It must be put into practice with regard for the environment, particularly to avoid all risk of river and eco system pollution.

In such condition, the application of controlled amount of VW is an olive fertilization practice that is friendly to the environment and crop, Anonymous (1996).

The aim of this study was to transfer technology on the application of vegetable water (VW) on agriculture land and to highlight the advantages of these practices in raising crop yields and improving soil fertility as a feature of sustainable, environmentally friendly Olive growing.

2.Material and Methods

2.1.Materials:

2.1.1.Subject

This research was carried out during 2009 and 2010. The main aim of this study was to investigate olive oil vegetable water (VW) on vegetative growth, leaf mineral content, flowering, fruit properties and oil quality of Manzanillo olive trees. Trees were grown in sandy soil, under drip irrigation system in a private farm located at desert road (about 50-Kilometer distance, Cairo) .Trees were about 10 years old planted at 5x5 meters apart, the experimental trees selected nearly uniform and vigour growth and free from pathological and physiological disorders received the same culture management (irrigation, weed, pests and disease control usually applied in the orchard except for the irrigation treatments)

The experiment was set in a complete randomized block design with three replicate, two trees per each

Totally four applications of the olive oil vegetable water were used , including 0 (control), 24, 48,72 litre were added to each tree in the end of canopy shade each two weeks during the period from the first of January till the end of fruit set. Four drippers under the canopy of the trees and each one gives 8 litre/hour per tree,(total 32 litre /hours) and irrigation time is 3 hours per day. The irrigation dose = 32x 3 = 69 litre per day of water.

The drippers were blocked as follow:

One dripper was blocked under the trees irrigated with 24 litre /tree of VW water).

-Two drippers were blocked under the trees irrigated with 48 litre /tree of VW.

-Three drippers were blocked under the trees irrigated with 72 litter/tree of VW.

-Physical and chemical properties of VW which products from olive oil three phase extraction mill collected during the late fall and winter season was determined at Soil and Water Research Institute, (WRI) ARC and illustrated in table (1).

-Analysis of the tested soil was carried out according to Seferoglu et al., (2000) in Soil and Water Research Institute, (SWRI) ARC

Farm fertilization (compost and mineral fertilization) were added at the second week of November and was applied in two parallel ditches of 100 x 40 x 30 cm, for length, width and depth respectively. The ditches surrounded the tree from two direction in the end of canopy shade. The amount of compost was 50 Kg/tree, the rate of mineral fertilization was100 gm nitrogen + 270 gm phosphorus + 720 gm potassium + 0.5 Kg of MgSo4 (9.6 % Mg) + 0.25 Kg as sulphur + 0.25 Kg Boron per tree

2.2.Methods:

2.2.1.Measurements:

-Soil analysis: soil samples were taken from the major root zone at the end of each growing season and ready for analysis; electrical conductivity (EC), soluble ions and soil pH. Soil chemical, physical

properties and nutrient availability were determined according to Chapman and Pratt (1978).

In each season of study fifteen shoots (one year old) were randomly chosen at each direction for the vegetative growth measurement

2.2.1.A- Vegetative growth

At the end of each growing season (during the first week of September) the following characteristics were measured:

1. The lengths of shoots in cm.
2. Leaves Density =Number of leaves per shoot and calculated per meter
3. Leaf area (cm2) according to Ahmed and Morsy (1999) using the following equilibration=0.53(length× width) +1.66

2.2.1.B- Leaf mineral contents:

At the first week of August of each season, leaf samples were taken from mid-shoot ,Piper (1950), and then washed; air dried at 70°C title the constant weight and grounded for the determination of N.P.K .as follows:

Nitrogen was determined by the Microkjeldahl method. (PregI, 1945)

Phosphorous was estimated by the method of (Murphy & Riely, 1962).

Potassium was determined by flame – photometer according to (Brown & Lilleland, 1946).

Calcium was determined using Atomic Absorption Spectropho-meter Perkin Elmer-3300 (Chapman& Pratt, 1961).

Microelements (Fe, Mn, Zn, Cu): as ppm were spectrophotometerically determined using atomic absorption (Model, spectronic21D) as described by Jackson (1973)

2.2.1.C- Flowering behaviour

- **Flowering dates** Inflorescences emergence: Date of Inflorescences emergence was recorded as soon as the first sign of Inflorescences parts were noticed.

-Blooming dates: Dates of beginning and full bloom were recorded when 10% and 80% of total flowers were opened, respectively .The end of blooming was recorded at the date in which all flowers were completely opened.

-Blooming Periods: The days between Beginning of flowering and end of blooming (Mofeed, 2002).

-Flowering Characteristics

Inflorescence length (mm): thirty inflorescences were randomly taken from each replicate and the length was calculated.

-Flowering density (as a number of inflorescences per meter): Average number of inflorescences per shoot was recorded and calculated per meter.

-Sex ratio: the percentage of perfect flowers to the total number of flowers was calculated in previously the thirty inflorescences at balloon stage for each replicate.

2.2.1.E- Fruit set and Yield:

Fruit set was calculated after 21 days from full blooming, Mofeed (2002). Numbers of fruits were recorded on each of the selected shoots and average yield (kg) per tree was recorded at harvesting date for every replicate tree from each treatment.

2.2.1.F- Physical and chemical characteristics of Fruits and stones

Fifty fruits per each tree were randomly selected and used to determine the following physical characteristics fruit length (cm),fruit diameter(cm),fruit weight(gm) and stones were extracted to determine stone length(cm),stone width(cm) .Stone weight(gm),flesh/fruit weight and flesh/stone ratio .

Fruit moisture and fruit oil content and quality were determined as follow :Fruit moisture was calculated according to A.O.A.C(1990). While Oil content (%) in dry weight was extracted by Soxelt apparatus from the dry fruit sample of Manzanillo Cv. using petroleum ether (60 – 80) as a solvent for 16 hours according to the method described by A.O.A.C (1995) . Oil quality as peroxide value was determined according to method described in A.O.A.C method

2.2.2.Statistical analysis:

The obtained data was subjected to analysis of variance (Anova) according to (Snedecor and Cochran 1980). Differences between treatments were compared by Duncan's multiple range tests as described in the SAS. (SAS, 1994) .

3.Result and discussion

3.1. Soil chemical and physical properties

Result of soil nutrient analysis are shown in Table (2) before adding VW and table(3)after adding VW at the end of study. It was observed that the applications of VW caused a pronounced increase in organic matter (%).The best result was observed in the trees received VW at 72 litre /tree , as well as, soil structure improvement was accompanied with decreasing Ec.The more application effect in this

respect is VW at 72 litre /tree. As for soil nutrient elements, the used VW increased available soil N ,K, P, and Ca, the highest values recorded with application of VW at 72 litre /tree.

Table (1): Analysis of olive oil vegetable water season 2009

Parameters	Values
PH	5.8
EC (Ms/cm)	6.7
Organic matter (%)	8.2
Organic Carbon C (%)	0.730
Total nitrogen (N) %	1.1
C/N	6.75 : 1
Total phosphorus (P) %	0.60
Total potassium (K) %	1.22
Total calcium (Ca) %	0.80
Total magnesium (Mg) %	1.35
Total Sodium (Na) %	0.4
Total Zinc (Zn) ppm	59
Total cupper (Cu) ppm	25
Total manganese (Mn) ppm	61

While the application of VW at 48 litre /tree gave the highest value of Mg element. Moreover, the applications of VW reduced , iron, cupper, and HCO_3 according to doses .The application of VW at 24 litre per tree decreased the accumulation of sodium and in addition the application of VW at 72 litre /tree per/tree, decreased chloride 3 while no change in CO_3 in the soil after application .Finally ,the application of VW improved physical and chemical characteristics of soil and that improved growth and yield .These results were a line with **Pinar** et al., (2003) and Berrin et al.,(2008) **.**

3.2.Vegetative growth:

Data in Table (4) depict the affect of applications of VW with three concentration (24L/tree , 48L / tree and74L/tree) on some growth parameters. The highest shoot length , No. of leaves/meter and leaf area (cm)were significantly influenced by different aforementioned applications compared to the control during two the growing season. Hence, the highest values of shoot length, No. of leaves/meter and leaf area (cm)were obtained for trees received the rate of 72 litre of VW/tree (26.93 cm, 27.37& 158.41, 171.52& 3.700, 3.753 in both seasons. These results were a line with Ammar and Ben(1999) in tomato plants who reported that spread different types of Olive oil waste water improved tomato growth that increase due to the increase of soil flora and development of specific micro organisms such as *cellulolytic* and *pectinolytic* bacteria .Al –Absi(2010) study on Olive trees suggested that the high concentration of Olive waste water used, significant increased in young shoot length, number of new shoots and leaf area of Nabali and Manzanillo trees than of the control tree and Georgia et al.,(2010) on wheat and Maize .

Table (2) samples in the experimental orchard Some physical and chemical properties of soil season

Elements	Values
PH	7.0
EC (Ms/cm)	3.12
CO_3 (M/L)	----
Hco3 (M/L)	2.47
Organic matter (%)	1.42
Total nitrogen (N) Mg/Kg	9.8
Total phosphorus (P) Mg/Kg	1.49
Total potassiun (K) Mg/Kg	7.32
Total calcium (Ca) Mg/Kg	11.13
Total magnesium (Mg) Mg/Kg	4.02
Total Sodium (Na) Mg/Kg	15.4
Total iron (Fe) Mg/Kg	8.77
Total cupper (Cu) Mg/Kg	0.43
Total chloride (Cl) Mg/Kg	14.55

3.3.Leaf mineral content

The effect of different applications on macro elements (N, P and K %) content and micro elements (Fe, Mn, and Zn ppm) content in Mnzanillo olive leaves was significant during the two seasons as shown in Table (5,6).

Table (5) represented that leaves nitrogen content under study ranged between 1.42g and1.66g/100g dry weight for treatments in the first season and 1.367g to 1.80g/100g dry weight for treatments in the second season The highest nitrogen percent in leaves (1.63 &1.820) obtained for treatment of 24 litters /tree in both seasons, as well as, the leaves of control trees gave the highest percentage of leafnitrogen in the first season only. Phosphorus content ranged between (0.50 to0.53) there was not a considerable increase in P content of the leaves after application in both seasons. Concerning Leaf potassium content, it was

ranged from 0.957& to1.367 %in the first season and from 1.35to 1,367% in the second season, the highest value was noticed at the rate of 72 liters /tree (1.376, 1.700) in both seasons. regarding leaves Ca content, it ranged from 1.40 to 2.150% in the first season, and in the second season it was from 2.110 to 2.703 %, treatment with 72 litre per tree gave the highest significantly content of calcium 2.150&2.703 in both studied seasons, from these results we can concluded that treatment trees with 72 litre per trees gave the highest content of P, K and Ca in two studied seasons .These results were in harmony with those obtained by Berrin et al., (2008) on fig trees.

Table (3) Some physical and chemical properties of soil samples in the experimental orchard season 2010

Elements	Control	V.W. 24 litre/tree	V.W. 48 litre/tree	V.W. 72 litre/tree
PH	7.8	7.75	7.75	7.65
EC (Ms/cm)	3.22	1.85	1.80	1.80
CO_3 (M/L)	--	--	--	---
H CO_3 (M/L)	2.77	1.92	1.75	1.65
Organic matter (%)	1.45	2.11	3.20	3.75
Total nitrogen (N) Mg/Kg	10	11.49	11.55	11.75
Total phosphorus (P) Mg/Kg	2.86	3.52	3.50	3.95
Total potassium (K) Mg/Kg	9.45	11.34	23.50	55.14
Total calcium (Ca) Mg/Kg	11.53	49.74	41.59	58.30
Total magnesium (Mg) Mg/Kg	4.32	4.66	16.12	9.87
Total Sodium (Na) Mg/Kg	15.0	4.03	20.68	11.32
Total iron (Fe) Mg/Kg	20.15	14.22	17.10	16.52
Total cupper (Cu) Mg/Kg	0.55	0.29	0.30	0.37
Total chloride (Cl) Mg/Kg	15	13.75	17	11

Table (4): Length of brunches leaves density and leaf area of Manzanillo olive cultivar during 2009 and 2010seasons.

Treatments	Length of branches		No. of leaves/meter		Leaf area (cm)	
	2009	2010	2009	2010	2009	2010
Control	24.24 b	27.53 a	101.41 c	117.67 c	3.630 c	3.651 b
24 L. of VW	24.50 b	26.52 b	120.50 b	131.33 b	3.640 c	3.712 a
48 L. of VW	25.13 ab	27.91 a	132.10 b	144.67 b	3.670 b	3.740 a
72 L. of VW	26.93 a	27.37 a	158.41 a	171.52 a	3.700 a	3.753 a

Table (5): Macro elements of Manzanillo olive cultivar during 2009 and 2010 seasons.

Treatments	N		P		K		Ca	
	2009	2010	2009	2010	2009	2010	2009	2010
Cont	1.66 a	1.653 b	0.50 a	0.52 a	0.957 b	1.350 c	1.140 d	2.110 c
24 L. of VW	1.63 a	1.820 a	0.51 a	0.53 a	1.360 a	1.600 b	1.370 c	2.160 c
48 L. of VW	1.44 b	1.727 ab	0.50 a	0.52 a	1.080 b	1.560 b	1.750 b	2.600 b
72 L. of VW	1.42 b	1.367 c	0.51 a	0.52 a	1.376 a	1.700 a	2.150 a	2.703

3.3.1.Leaf micro element (Mn, Zn, ,Cu)

Data in Table (6) showed that, leaf content of micro elements was significantly affected by different treatments in both seasons. , results cleared that the application of VW at72 litters /tree was the superior treatment which increased the micronutrient Mn (115.00 and155.20) in both seasons, the same application increased the Zn

(65.04,) in the first season . Concerning Cu content, the highest leaf content was observed with control treatment (19.33& 19.00), in 2009 and 2010respectively .These results was agreement with Asfi et al., (2006) ;Berrin et al., 2008; Ouzounidou et al., (2008),they found that spinach and peas treated with raw and diluted OMWW leaves content of Ca, Mg and K were increased, while leaves content of Fe were decreased .

Moreover, the decrease in photosynthesis can be related to the significant decrease observed in leaf Fe concentration ,Morales et al., (1998).

Application of OMWW demonstrated a significant increase in P concentration in the roots but not in the leaf. OMWW is known to increase soil organic matter and the concentrations of essential inorganic elements for plant growth resulting in enhanced soil fertility, Paredes et al., (1999).

Table 6): Micro elements of Manzanillo olive cultivar during 2009 and 2010 seasons.

Treatments	Mn		Zn		Cu	
	2009	2010	2009	2010	2009	2010
Control	86.00 c	90.00 d	61.11 c	67.00 d	19.33 a	19.00 a
24 L. of VW	106.10 b	144.70 b	63.60 b	77.36 a	18.20 b	18.42 b
48 L. of VW	78.41 d	133.50 c	58.79 d	76.00 b	16.93 c	15.73 d
72 L. of VW	115.00 a	155.20 a	65.04 a	74.12 c	16.03 d	17.06

3.4.-Flowering behavior:

3.4.1.Flowering dates and Flowering Period:

Beginning , end of blooming and duration stand in Table (7) and fig (1). It appears that, all the investigated trees bloomed at the same date with no difference between treatments(30/3 &23/3)) in both studied seasons , except control was earlier 4 days in the (26/3)first season and 2 days (21/3)in the second season. The blooming duration was about 11 days in control and 9 days in other treatments in the first season, but in the second season the blooming duration was 11 days in all treatments. As general tend the blooming started earlier in the second season, it is notice from the results that the duration of flowering differed from one season to another

Table (7): Flowering of Manzanillo olive cultivar during 2009 and 2010 seasons.

Treatments	Blooming period	
	2009	2010
control	26/3 to 7/4	21/3 to 2/4
24 L. of VW	30/3 to 9/4	23/3 to 4/4
48 L. of VW	30/3 to 9/4	23/3 to 4/4
72 L. of VW	30/3 to 9/4	23/3 to 4/4

Treatments		Blooming Period																		
		21/3	22/3	23/3	24/3	25/3	26/3	27/3	28/3	29/3	30/3	31/3	1/4	2/4	3/4	4/4	5/4	6/4	7/4	8/4	9/4
Control	2008																				
	2009																				
24L. of VW	2008																				
	2009																				
48L. of VW	2008																				
	2009																				
72L. of VW	2008																				
	2009																				

Fig (1): Blooming period of Manzanillo olive cultivar during 2009 and 2010 seasons.

3.4.2.Length of inflorescences:

Data in Table (8) showed that all treatments gave the significantly higher length of inflorescences than control. Vegetable water at the rate of 72 litre/tree gave the highest length of inflorescences (2.86 & 2.65 cm) in both studied seasons ,while control treatment was the least one (2.55) in the first season ,the trees which treated with 24 litre of VW gave the least length of inflorescences (2.45) in the second season. These results agreed with Kistner et al., (2004) who found that addition of OMWW at a rate of 5% resulted in significantly higher shoot length and number of leaves as compared to the untreated control at maintained inter node length. Also, fresh weight of leaves, stems and roots from plants exposed to bio-OMWW increased in comparison to the untreated control plants.

Table (8): Inflorescence characteristic of Manzanillo olive cultivar during 2009 and 2010 seasons.

Treatments	Length of inflorescences (mm)		Number of inf./meter		Sex ratio	
	2009	2010	2009	2010	2009	2010
Control	2.55 c	2.52 c	66.70 d	57.36 d	37.00 d	50.44 d
24 L. OF VW	2.74 b	2.45 d	82.32 c	74.57 b	56.0 c	54.0 c
48 L. OF VW	2.73 b	2.58 b	84.11 b	70.89 c	74.41 a	74.41 a
72 L. OF VW	2.86 a	2.65 a	86 42 a	80.42 a	65.60 b	67.93 b

3.4.3. Flowering density:

Flowering density as measured by number of inflorescences per meter responded significantly to all treatments used in both studied seasons as compared with control trees which exhibited the least average number of inflorescences, Table (9). The most pronounced significant effect was associated with 72 litre of VW/tree (86.42 & 80.4) in both seasons

3.4.4.Sex expression ratio

Percentage of sex expression ratio of Manzanillo olive trees as affected by treatments, was varied from (37.0 to 74.41 %) in the first season and from (50.44 to 79.67 %) in the second season. Data in Table (8) observed that treated trees with (48 litre of VW) induced an apparent significant increase in sex expression of Manzanillo trees in both seasons.

4.5.-Fruiting (Fruit set and yield):

Data presented in Table (9) indicated that number of fruits ranged from (25.38 to 39.55) in the first season, while it ranged from (20.45 to 29.94) in the second season. Generally, all treatments improved fruit set over control, treated tree with 48 litre of VW was the most effective and resulted in the highest significant values in this respect. In the same table and Fig (2); yield (kg/tree) was (19.05&12.52) in the control trees and was (32.0 & 26.0) in the treated trees with vegetable water at 48 litre in both experimental seasons. These results coincide with Georgia et al., (2010) and Ouzounidou et al., (2010), who reported that OMWW land application promoting crop yield of Wheat and Maize , El-Hadrami et al., (2004)

Table (9): fruit set and yield of Manzanillo olive cultivar during 2009 and 2010 seasons.

Treatments	fruit set		Yield	
	2009	2010	2009	2010
control	25.38 d	20.45 d	19.05 d	12.52 c
24 L. of VW	27.52 c	25.14 c	22.13 c	20.10 b
48 L. of VW	39.55 a	29.94 a	32.0 a	26.0 a
72 L. of VW	31.64 b	27.33 b	25.41 b	21.19 b

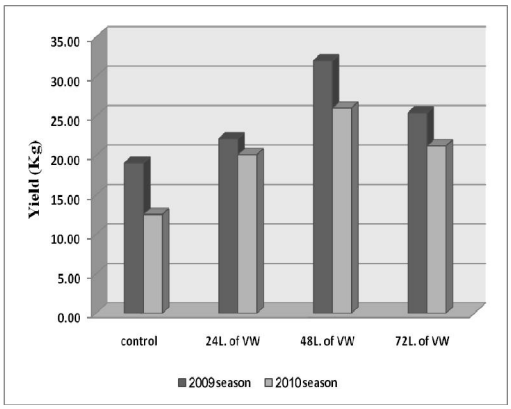

Fig (2): Yield of Manzanillo olive cultivar during 2009 and 2010 seasons.

3.6. Fruit physical and chemical properties

3.6.1. Fruit length, diameter and weight:

Data in Table (10) indicated that the maximum fruit length, diameter and weight associated with vegetable at 24 litre/tree(2.72, 2.65) in fruit length,(2.18 ,2.3) in fruit width (6.35 ,6.42) in fruit weight as compared with other treatments.The differences reached up to level significant. However, the minimum values were obtained by the treatment at rate 72 litre per tree.

3.6.2.-Stone length, diameter and weight:

Data in Table (11) showed that there were no difference with regard to the specific effect of the studied treatments in two studied seasons in both stone length and width, while stone weight was affected by application of VW at 48 litre.It gave the highest values (0.823, 796) in both seasons.

Table (10): fruit length, width and weight of Manzanillo olive cultivar during 2009and 2010 seasons.

Treatments	Fruit length (cm)		Fruit width(cm)		Fruit weight (gm)	
	2009	2010	2009	2010	2009	2010
Control	2.61 b	2.52 c	2.16 b	2.12 b	5.38 c	5.60 b
24 L. of VW	2.72 a	2.65 a	2.18 a	2.23 a	6.35 a	6.42 a
48 L. of VW	2.59 b	2.58 b	2.15 b	2.28 a	5.68 b	5.63 b
72 L. of VW	2.50 c	2.44 d	2.15 b	2.12 b	5.12 d	5.36 c

Table (11): stone length, width and weight of Manzanillo Olive cultivar during 2009and 2010 seasons .

Treatments	Stone length (cm)		Stone width (cm)		Stone weight (gm	
	2009	2010	2009	2010	2009	2010
Control	1.55 a	1.513 b	0.890 a	0.786 a	0.730 b	0.730 b
24 L. of VW	1.56 a	1.617 a	0.906 a	0.913 a	0.763 b	0.753ab
48 L. of VW	1.60 a	1.627 a	0.913 a	0.916 a	0.823 a	0.796 a
72 L. of VW	1.58 a	1.627 a	0.896 a	0.916 a	0.740 b	0.730 b

Flesh, flesh / fruit weight and flesh / stone weight.

The overall trends in the effect of tested treatments were presented in Table (12). The trends indicated a significantly increase in Flesh weight (5.54 & 5.61), Flesh/fruit weight percent (87.24 & 87.38) and flesh/stone ratio (6.37&7.04) were observed in the trees received 24 litre (VW) per tree followed by 48 litre (VW) in Flesh weight, while in Flesh/fruit weight percent treatments with 48&72 litre(VW) were the same in statically analysis .On the other hand, the treatment with 72 of VW was the least and nearly with control in flesh/stone ratio in two studied seasons. These results from Tables 10& 11and 12 are in agreement with Georgia et al., (2010) on Tomato plants that an increase on weight of tomato fruit with the application with olive mill waste water and Benrouina et al., (1999) on young olive plant.

Table (12) : Flesh weight ,Flesh/fruit weight and Flesh/stone of Manzanillo Olive cultivar during 2009 and 2010 seasons .

Treatments	Flesh weight		Flesh/ fruit weight %		Flesh/stone ratio	
	2009	2010	2009	20010	2009	2010
Control	4.38 c	4.86 b	81.41 c	86.79 b	5.97 c	6.65 b
24 L. of VW	5.54 a	5.61 a	87.24 a	87.38 a	6.73 a	7.04 a
48 L. of VW	4.90 b	4.87 b	86.20 b	86.55 b	6.42 b	6.48 b
72 L. of VW	4.40 c	4.63 c	86.0 b	86.30 b	5.98 c	6.17 d

Table (13): fruit moisture Percent and oil Percent in fresh and dry weight of Manzanillo olive cultivar during 2009 and 2010seasons

Treatments	moisture Percent		Oil Percent (DW)	
	2009	2010	2009	2010
control	70.79 a	69.03 a	20.29 c	22.78 c
24 L. of VW	65.48 b	63.33 b	25.37 b	27.48 b
48 L. of VW	56.12 c	55.63 c	33.58 a	34.62 a
72 L. of VW	58.45 c	56.67 c	31.83 a	32.36 a

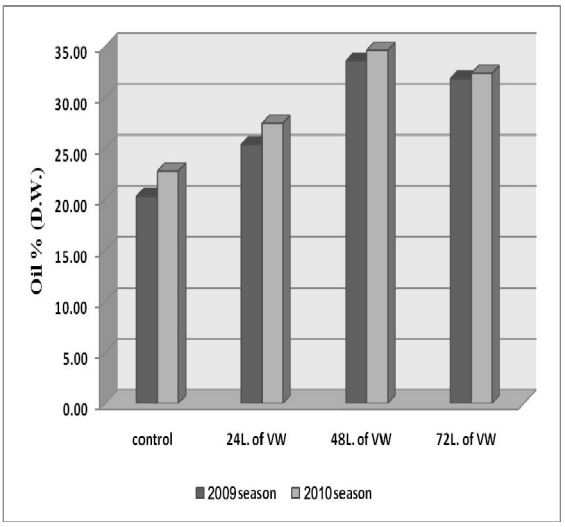

Fig (3): Oil Percent in dry weight of Manzanillo olive cultivar during 2009 and 2010 seasons.

3.6.3.Fruit moisture and oil content:

Data presented in Table (13) and fig. (3) revealed that fruit moisture content (%) and fruit oil content (%) in dry weight were significantly affected by (VW) applications in both seasons. Control treatment gave the highest fruit moisture content(%) as it averaged (70.79%)in the first season and (69.03) in the second season. Fruit oil content of Manzanillo cv. valid from (20.29 to 33.58%) in the first season and from (22.78to 34.62%) in the second season. Data in table (11) showed that adding VW at 24 and 48 litre per tree gave the highest fruit oil content in dry weight in both seasons, , while control treatment was the least fruit oil content (20.29 &22.78%)in dry weight in both seasons. These results are different with El-Hassani et al., (2009) on Spearmint plant , who observed that treated plants with olive mill waste water decreased oil yield .

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