

FERTIGATION MANAGEMENT TO MAXIMIZE OLEUROPINE CONTENT IN OLIVE LEAVES

F. A. A. Hassan, * A. H. Abd-Elaty * and A. A. Abd-Elmonsef *

ABSTRACT

This study was conducted for three successive seasons (2015/2016/2017) on Chemlali olive trees 15 year's old at a private orchard, located on the 32 km Cairo–Alexandria desert road. The main aim of the present research is to study the effect of irrigation system (dripper and bubbler); deficit irrigation regimes "DIR" (75 % and 50 % ETc.) and 4 additional doses of urea by two rates of dose (200 gm and 400 gm), injected throughout irrigation system , with a rate of (1 kg./100 l), during March, on vegetative growth " number of new shoots; shoot length; shoot diameter; number of leaves per shoot and leaf area"; fruit yield; alternative bearing index and Oleuropein concentration in the olive leaves. The following treatments were applied: T1: control (100% ETc. by drip with recommended fertilization rate); T2 (50% of ETc. by drip + 0.8 kg urea/tree); T3 (50% of ETc. by drip + 1.6 kg urea/tree); T4 (75% of ETc. by drip + 0.8 kg urea/tree); T5 (75 of ETc. by drip+1.6 kg urea/tree) T6 (50 % of ETc. by bubbler + 0.8 kg urea/tree); T7 (50% of ETc. by bubbler + 1.6 kg urea/tree); T8 (75% of ETc. by bubbler + 0.8 kg urea/tree) and T9 (75% of ETc. by bubbler+1.6 kg urea/tree). The results indicated that, all parameters of the vegetative growth and fruit yield increased by using bubbler 100l/h and applying the proposed DIR with additional doses of urea. The highest value of alternative bearing index was 0.256 recorded with control treatment (T1). Meanwhile the lowest alternate bearing index was 0.131 recorded with (T9). Oleuropein concentration in the olive leaves increased with all tested treatments compared with (T1), the lowest value of Oleuropein content was 58 (mg/100gm) obtained under the control treatment (T1). The highest values of Oleuropein content were 316.59 (mg/100gm) obtained with (T9).

* Ag. Eng. Res. Inst., Ag. Res. Center, Dokki, Giza, Egypt.

Thus, applying DIR 75 % Etc. with 4 additional doses of urea (400 gm for each) during March by using bubbler system, with saving 25% of irrigation water, will improve vegetative growth and reduce the severity of alternative bearing, as well as increase the Oleuropein concentration in the olive leaves.

Key words: *Olive trees; deficit irrigation regime; dripper; bubbler; fertigation; Olive leaves; vegetative growth; alternative bearing index and Oleuropein concentration.*

1.INTRODUCTION

Olive tree (*Olea europaea L.*) is one of the most important fruit trees in Mediterranean countries, where they cover 8 million ha, accounting for almost 98% of the world crop. This demonstrates the great economic and social importance of this crop and the possible benefits to be derived from utilization of any of its by-products, Guinda *et al.* (2004) & Tabera, *et al.* (2004). The Egyptian olive production reached about 698,927 ton produced from 227,683 feddan with (168 trees/feddan), M.A.L.R (2015). Although, the Ministry of Agriculture plans to cultivate one million new olive trees in Sinai, most owners of olive orchards especially at Cairo-Alexandria desert road decided to remove those orchards and replanting with other more profitable fruit trees due to the poor yielding. Where Olive is notorious alternate bearing (AB) which characterize by high crop in one year (On-year) and low or no crop in subsequent year (Off- year). AB is variety specific, but influenced by the growing environment (climate and soil) and horticultural practices which may increase or reduce the severity of AB or may lead the trees to enter the cycle of this phenomena, Cimato and Fiorino (1986). Several trails were carried out to study the use of different plant growth regulators for the control of flower and fruit numbers on olive tree, so as to diminish the AB, Cuevas *et al.* (1994). Extensive olive cultivation, characterized by the irregular supply of water and particularly nutrients, is considered to be one of the reasons for the high fluctuations in olive yield, Barranco *et al.* (1998). In advanced intensive cultivation of olives, based on fertigation technology, the

continuous application of nutrients is addressed far well than in traditionally cultivated olive groves. Some studies in recent years have clearly demonstrated the effect of a novel foliar nutrient system, applied just before the olive blooms at the beginning of the spring in significantly increasing the olive yield in both “on” and “off” years, Wiesman *et al.* (2002, c & d). Troncoso *et al.* (1997) Observed after eight years of 2 kg of urea (46%) per tree fertigation, an increase on vegetative growth and yield in 25-years-old ‘Manzanilla de Sevilla’ trees, while fruit weight was not affected. Olive has been traditionally grown rain-fed conditions and is considered one of the best adapted species to the semi-arid environment, Giménez, *et al.* (1997). However, under this condition it usually shows a decrease in photosynthesis that limits growth and yield, Bonghi, G. and A. Palliotti (1994). Most research work dealing with irrigation of olive orchards showed that trees respond favorably and quickly even when low volumes of water are applied, Aiachi *et al.* (2007 and 2008); Masmoudi-Charfi and Ben Mechlia, (2007 and 2008). Furthermore, supplying trees with suitable amounts of water, given at precise stages of tree and fruit development, provide a better control of nutrients and carbohydrate’s distribution, leading to more regular yields, Fernandez and Moreno, (1999); D’Andria *et al.* (2008); Iniesta *et al.* (2009); Palese *et al.*, (2010). Several methods, approaches and concepts were developed during the last decade, in order to determine more precisely the amount of water requested by trees for their growth and production, Palomo *et al.*, (2002); Fernandez (2006). The current trend in the irrigation of olive trees is to develop either sustained deficit irrigation (SDI) or regulated deficit irrigation (RDI) strategies, whereby the water is applied at a rate less than the needs of evapotranspiration with only very small reductions in yield, Goldhamer (1999); Tognetti *et al.* (2005). Under conditions of scarce water supply and drought, SDI and RDI irrigation regimes at selected phonological phases, can lead to greater economic gains than simply maximizing yields per unit of water as shown by Tognetti *et al.* (2006). However, they cautioned this approach requires precise knowledge of crop responses to water stress at specific physiological stages. The term of “olive leaves” refers to a mixture of leaves and branches, are one the by-products of farming of the olive

grove. Olive leaves can be found in large amounts in the olive oil industries (10% of the total weight of the olives) and they accumulate during the pruning of the olive trees (about 25 kg of by-products (twigs and leaves) per tree annually), Herrero *et al.* (2011). The leaf is the primary site of plant metabolism, at the level of both primary and secondary plant products Antolovich, *et al.* (2000) and can be considered as a potential source of bioactive compounds, Tsimidou, and Papoti (2010). The main category of those compounds is secoiridoids that are present in Oleaceae and other few dicotyledonous plant families, Alagna *et al.* (2012). One of the most dominant secoiridoid found in olive leaves is oleuropein, Sahin *et al.* (2012). Oleuropein in the olive leaves varies from 17% to 23% depending upon the harvesting time of the leaves, Le Toutour, and Guedon (1992). Olive leaves also contain other bioactive phenolics like phenyl ethyl alcohols (tyrosol and hydroxytyrosol), simple phenols (caffeic acid, p-coumaric acid, vanillic acid, vanillin, etc.) and flavonoid-like compounds (verbascoside, luteolin, diosmetin, rutin, luteolin-7-glucoside, apigenin-7-glucoside and diosmetin-7-glucoside, etc.), Vissers *et al.* (2004); Lee *et al.* (2009); Hayes *et al.* (2011) and Ahmad-Qasem *et al.* (2013). All these compounds could be of interest to the pharmacological, nutraceutical, cosmetic, and food industries. Therefore, the rational use of olive tree waste materials could have perspective future, Peralbo-Molina and Luque de Castro (2013). Olive leaf was first used medicinally in Ancient Egyptian and was symbol heavenly power. A few decades later green olive leaves were used in tea as a treatment for malaria, Somova *et al.* (2003); science then several researcher demonstrated antiviral, Micol *et al.* (2005); anti-HIV; antimicrobial, Bisignano *et al.* (1999); antioxidant and anti-inflammatory, Briante *et al.* (2002); and anti-carcinogenic properties that lead to the prevention of some cancers, Owen *et al.* (2004). And finally stimulation of the thyroid activities of olive leaf extracts Al-Qarawi *et al.* (2002). Oleuropein, a bitter-tasting secoiridoid glycoside present in olive leaves, is suggested to support hypotensive activity, have preserving activity against lung cancer, colorectal, pharyngeal and esophagus cancer, Uccella and Saija (2001). The hypothesis of this study was that, to compensate the reduction of olive fruit yield, during off year season

due to AB, using a suitable irrigation system and applying deficit irrigation regime (DIR) with timely doses of urea (at March), will improve the vegetative growth; reduce the severity of AB and increase olive leaves contents of Oleuropein.

The main objective of this research was to study the effect of irrigation system (dripper and bubbler) and applying different deficit irrigation regimes (50% and 75 % ETc.) with additional doses of urea, on the vegetative growth; fruit yield and alternative bearing index as well as the concentration of Oleuropein in olive leaves.

2.MATERIALS AND METHODS

2.1. Experimental site:

This study was carried out during three successive seasons, (2015/2016/2017) at a private orchard located on the 32 km from Cairo– Alexandria desert road (30.077905, 30.999313), on olive trees (*Olea. europaea L. cv Chemlali*) 15 years old cultivated at spacing of 5x5 m under semi-arid conditions in a sandy soil. The orchard soil and irrigation's water weal analysis are given in (Table 1 and 2) according to procedures which are outlined by, Wild *et al.* (1985). The selected trees were uniform in shape; vigor; size; normal growth and were going to an expected “off year” and received regular horticultural practices such as irrigation; fertilization; pruning; hoeing and pest or fungi control management that were carried out in the Chemlali olive orchards. The site is characterized by hot or worm in summer and cool in winter, with an average temperature in winter and summer of 14°C and 30°C respectively, and receives less than 80 mm of precipitation annually as in most areas of Egypt, FAO (2011).

2.2. Experimental material

2.2.1. Irrigation and Fertilization Management:

- To determine the best fertigation management plan that can be applied when expecting off year season, to decrease the severity of AB and compensate the reduction on fruit yield by stimulate the tree to increase vegetative growth and Oleuropein content in Olive leaves. This study carried out at one feddan experimental area “120X35m²” cultivated with 168 trees (24 rows with 7 trees for each), divided into two main plots (84 trees) at 12 rows.

Table 1: Physical and chemical analysis of the soil at the experimented orchard.

Character	Value	Character	Value
Pore size distribution (%)			
Coarse Sand	40 -74	EC (ds/m)	0.38
Fine Sand	54-79	pH	9.2
Silt + clay	4.74	Organic matter	0.57
Textural class	Sandy	CaCO ₃	
Soluble Cations (meq/l)		Soluble Anions (meq/l)	
Ca	1.25	HCO ₃	1.18
Ma	0.60	Cl	1.80
Na	1.60	SO ₄	0.75
K	0.20		

Table 2: Chemical analysis of water weal used at the experimented orchard.

EC	pH	Soluble cations (meq/l)				Soluble anions (meq/l)			
		Ca	Ma	Na	K	CO ₃	Hco	Cl	SO ₄
0.95	7.5	1.50		5.10	0.40	0.0	2.1	4.90	2.5

The 1st main plots irrigated with bubbler 100 l/h (one bubbler /tree) and the other fitted with a line of dripper's along the trees, four emitters 8 l/h per tree, being two of them on each side of the tree 1 m apart from each other. Each main plot divided into two sub plots (42 trees) at 6 rows, the 1st sub plots subjected to deficit irrigation regime (DIR) 50 % ETc. and the other 75 % ETc. Each sub plot divided into two sub sub plots (21 trees) at 3 rows. The 1st sub sub plots injected by additional 4 doses of urea 200 gm and the other injected by 400 gm /tree during March. The system included a main valve, a main water meter, a pressure regulator, pressure gauges, and a 120 mesh in 2 disk filter. Each lateral was equipped with a valve to stop and/or control water flow at any time and with water meters to measure the desired water flow according to the irrigation schedule, as well as venture type injector to supply the nutrients solution only to the experimental trees. Irrigation pipes and disk filters were flushed weekly to avoid clogging of any of the orifices.

- According to Salama *et al.* (2016) the recommended irrigation and fertilization for olive tree fruit yield production by Min. of Agric. Egypt, was that, irrigation rate” 100 % ETc.” = 2526 m³/faddan/year.

Meanwhile fertilization rates divided into three doses applied at January (before flowering) as NPK; June (after fruits set) as NK and August (after pit hardening) as NK, mixed with the soil surface layer (20 cm depth) surrounding the trunk at the external end of canopy shade. The olive trees required actual nitrogen (1 kg/ tree /year) equal 5 Kg ammonium sulfate (20.6 % N) or 3 kg ammonium nitrate (33.3 % N). Mineral phosphate fertilizer was added by rate 1.75 Kg of super phosphate (15.5 % P₂O₅) per tree. In addition, 1.50 Kg of potassium sulfates (48 % K₂O) per tree was added as a soil application divided into two equal doses, at the 2nd week of December combined with phosphate. Table (3) shows the average amount of irrigation water (m³/fed) applied monthly with different deficit regime during annual growing season.

Table (3): Average amount of water applied (m³/fed) during annual growing season.

Months	Amount of water applied (m ³ /fed)		
	100 % Etc	75 % Etc	50 % Etc
January	67.2	50.4	33.6
February	67.2	50.4	33.6
March	161.28	120.96	80.64
April	161.28	120.96	80.64
May	403.2	302.4	201.6
June	403.2	302.4	201.6
July	403.2	302.4	201.6
August	403.2	302.4	201.6
September	161.28	120.96	80.64
October	161.28	120.96	80.64
November	67.2	50.4	33.6
December	67.2	50.4	33.6
Total amount	2526	1895	1263
Saving amount		25 % = 631.68 m ³	50 % = 1263.36 m ³

2.2.2. Experimental design:

The treatments will be arranged in a split split plot design (SSPD), where the irrigation method at the main plot; the irrigation regime at the sub plot and the doses of urea at sub sub plot. Data were statistically

processed with Excel 2010 program. Table (4) shows the applied treatments for each plot.

Table 4: Experimental applied treatments:

Treatments	Irrigation system	Water regime level % ETC.	Fertilization (kg/tree)
T1*	Control	100%	----
T2	drip	50%	0.8 kg.
T3	drip	50%	1.6 kg.
T4	drip	75%	0.8 kg.
T5	drip	75%	1.6 kg.
T6	bubbler	50%	0.8 kg.
T7	bubbler	50%	1.6 kg.
T8	bubbler	75%	0.8 kg.
9T	bubbler	75%	1.6 kg.

* T1: control treatment (21 trees) selected randomly from the remaining orchard trees outside the experimental area, that receiving only the recommended irrigation and fertilization rates.

2.2.3. Treatments:

- Two types of irrigation system: dripper (8 l/h) and bubbler (100 l/h);

-Three level of deficit irrigation regime:

1- 100% ETc. = 2526 m³/feddan/year (control);

2- 75% ETc. of water irrigation required (1895 m³/faddan/year);

3- 50% ETc. of water irrigation required (1263m³/faddan/year);

and

- Two additional doses of urea:

1- (0.8 kg/tree) and 2- (1.6 kg /tree); Distributed at 4 doses of (200 gm or 400 gm for each); injected during March, through irrigation system with a mixing rate of (1 kg / 100 liter).

2.3. Measurements and Analysis:

On early January of each season, twenty healthy one year old shoots, well distributed around periphery of each tree were randomly selected and labeled for carrying out the following measurements.

2.3.1. Vegetative Growth:

At the end of each growing season during first week of September, four branches on all direction were chosen and labeled in each tree. The vegetative parameters were measured and determined as the following.

a. Number of new shoots (current season growth). b. Shoot length (cm).
 c. Shoot diameter (mm). d. Number of leaves per shoot. e. Leaf area (cm²).
 Calculated according to (Ahmed and Morsy, 1999) by using the following equation:

$$\text{Leaf area} = 0.53 (\text{length} \times \text{width}) + 1.66. \text{ ----- (1)}$$

2.3.2. Yield:

Olives were start harvested at mid-September every season when about 75% of the olives reached mature stage, fruits of each tree were separately harvested, then weighed and yield was estimated as Kg/tree.

2.3.3. Alternative bearing Index (ABI):

From the recorded yield for each tree through three seasons, the ABI was calculated by using the following equation according to Pearce *et al.* (1967).

$$\text{ABI} = (1/n-1) ((a_2-a_1)/(a_1+a_2) + (a_3-a_2)/(a_2+a_3) + (a_n - a_{n-1})/(a_{n-1}+a_n)) \dots (2)$$

Where: n: is the number of years of evaluation

a₁, a₂, a₃, .. a_{n-1} are the fruit production per tree (kg/tree) which were measured in the respective period of analysis (seasons of 2015 to 2017).

2.4. Determination of Oleuropein in Olive leaf extracts by HPLC.

Oleuropein concentration in the olive leaves extract, determined by using HPLC instrument. Samples were prepared according to the method described by Jakopič *et al.* (2009). Olive leaves samples were obtained from trees localized in the sunshine area, collected directly from the trees in the middle of November 2016. Fresh olive leaves were dried at ambient temperature, and grinded to obtain olive fine powder which was stored at room temperature in dark until extraction. 100 mg of the sample was measured into a test tube. Weights of samples were extracted with 10 ml methanol in ultrasonic bath for 45 minutes. Then the samples were centrifuged for 7 minutes at 4200 rpm. The supernatant was filtered through polyamide filter Chromafil AO-45/25, transferred into vial prior analyses. All chromatograms were plotted at 280 nm to estimated phenolic acids and at 330 nm for flavonoids. All components were identified and quantified by comparison of peak areas with external standards, Schieber *et al.* (2001). All processes of samples preparation and analysis carried out at the lab of Food Technology Research Institute.

3. RESULTS

(1) Effect of irrigation system; deficit irrigation regime and additional doses of urea, on vegetative growth characteristics.

(a) Number of new shoots (current season growth).

Fig. (1 a): shows the effect of irrigation system; deficit irrigation regime “DIR” and additional doses of urea, on the number of new shoots. The maximum values of number of new shoots were 17.67; 16.71; 16.68 and 14.71 recorded with treatments T9, T8, T7 and T6. Meanwhile the minimum number of shoots was 10.29 recorded with control treatment T1 through 2017. The previous results were at the same trend.

(b) Shoot length (cm).

Fig. (1 b): shows the effect of irrigation system; deficit irrigation regime DIR and additional doses of urea on shoot length. The maximum values of shoot length were 27.52 and 26.58 cm recorded with treatments T9 and T7. Meanwhile the minimum value of shoot length was 23.61 cm recorded with treatment T1 through 2017, the previous results were at the same trend.

(c) Shoot diameter (mm).

Fig. (1 c): shows the effect of irrigation system; deficit irrigation regime DIR and additional doses of urea, on shoot diameter. The maximum values of shoot diameter were 2.65 and 2.57 mm recorded with treatments T9 and T7. Meanwhile, the minimum value of shoot diameter was 2.19 mm recorded with treatment T1 through 2017, the previous results were at the same trend.

(d) Number of leaves per shoot.

Fig. (1 d): shows the effect of irrigation system; deficit irrigation regime DIR and additional doses of urea, on shoot length. The maximum values of number of leaves per shoot were 35.5 and 33.0 recorded with treatments T9 and T7. Meanwhile, the minimum value of number of leaves per shoot was 25.34 recorded with treatment T1 through 2017, the previous results were at the same trend.

(e) Leaf area (cm²).

Fig. (1 e): shows the effect of irrigation system; deficit irrigation regime DIR and additional doses of urea, on leaf area (cm²). The maximum values of leaves area were 5.31cm² and 5.11 cm² recorded with

treatments T9 and T7. Meanwhile, the minimum value of leaves area was 3.69 cm² recorded with treatment T1 through 2017, the previous results were at the same trend.

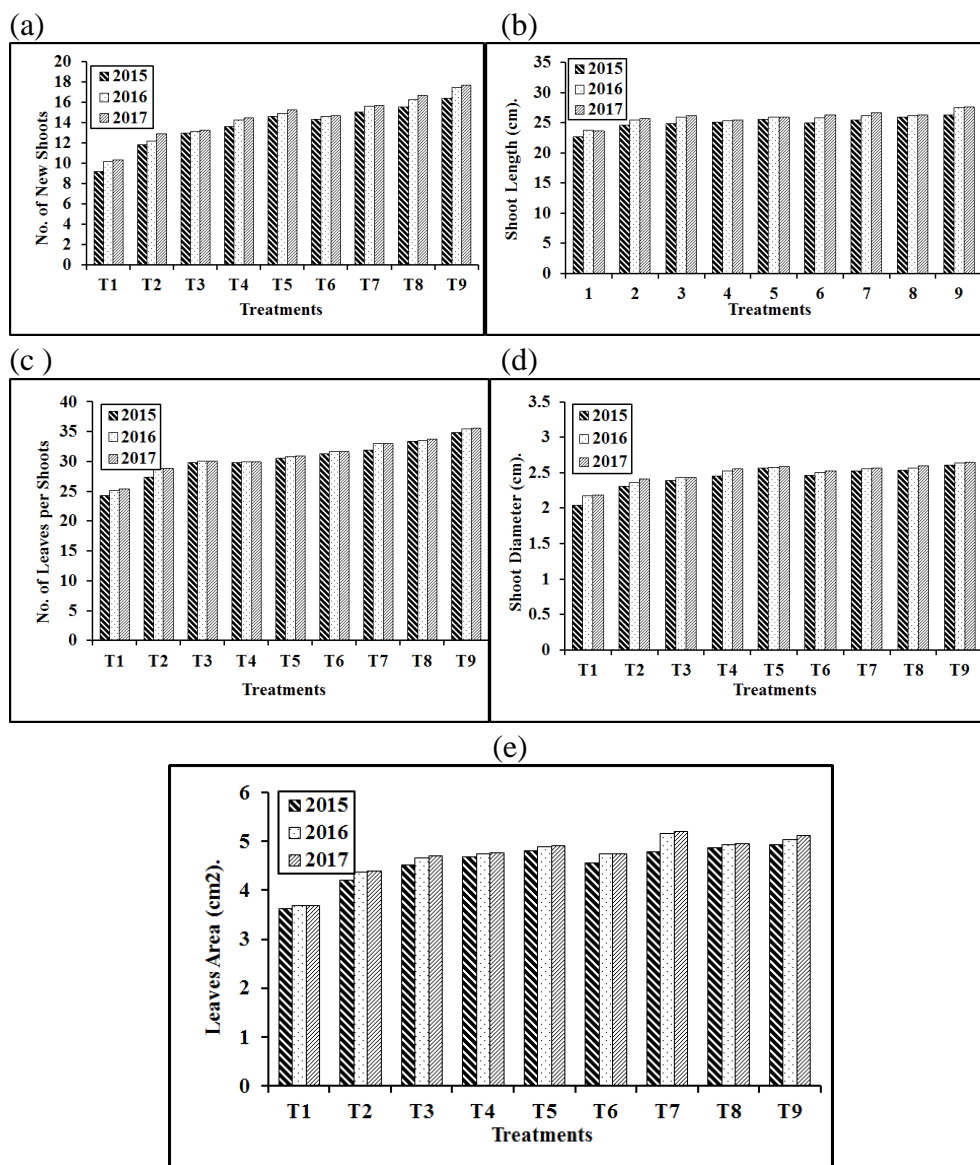


Fig. (1): Effect of irrigation system; deficit irrigation regime and additional dose of urea, on (a) number of new shoot (b) shoot length, (c) shoot diameter, (d) number of leaves per shoot and (e) leaf area (cm²).

(2) Effect of irrigation system; deficit irrigation regime and additional doses of urea on fruit yield.

Fig. (2): shows the effect of irrigation system; deficit irrigation regime (DIR) and additional doses of urea, on fruit yield (kg). The maximum values of yield were 31.16 kg recorded with treatments T9. Meanwhile, the minimum value of yield was 15.61 kg recorded with treatment T1 through 2015. On the other hand, the highest value of yield at 2017 was 52.84 kg recorded also with treatments T9. Meanwhile, the lowest yield value at 2017 was 44.61 kg recorded with T1. This result revealed that, the fruit yield at 2015 was very week (off year) for all treatments compared with 2016 and 2017.

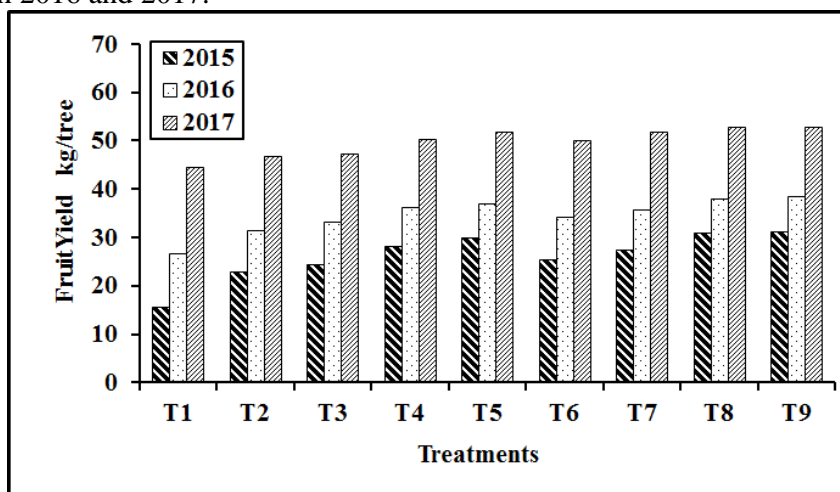


Fig. (2): Effect of irrigation system; deficit irrigation regime and additional doses of urea, on fruit yield.

(3) Effect of irrigation system; deficit irrigation regime and additional doses of urea on alternative bearing index.

Fig. (3): shows the effect of irrigation system; deficit irrigation regime and additional doses of urea, on alternative bearing index. The highest value of alternate bearing index was 0.256 recorded with control treatment (T1). Meanwhile, the lowest alternate bearing index was 0.131 recorded with (T9).

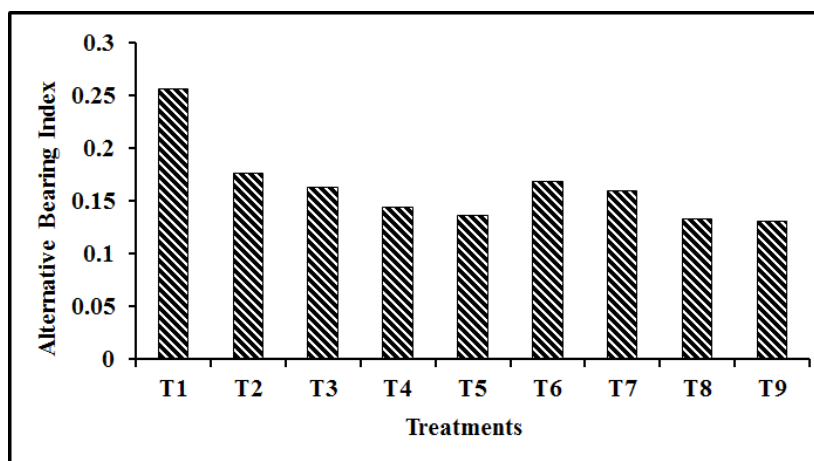


Fig. 3: Effect of irrigation system; deficit irrigation regime and additional doses of urea on alternative bearing Index.

(4) Effect of irrigation system; deficit irrigation regime and additional doses of urea, on Oleuropein concentration in olive leaves.

Fig. (4): shows the Oleuropein concentration in olive leaves extract obtained with all treatments. The maximum level of Oleuropein concentration in olive leaves extract was 316.59; 309.75 and 297.70 mg/100g dry mater, recorded with treatments T9; T8 and T5 respectively. Meanwhile the minimum level of Oleuropein concentration was 58.56 mg/100g recorded with treatment T1 from samples taken through season 2016.

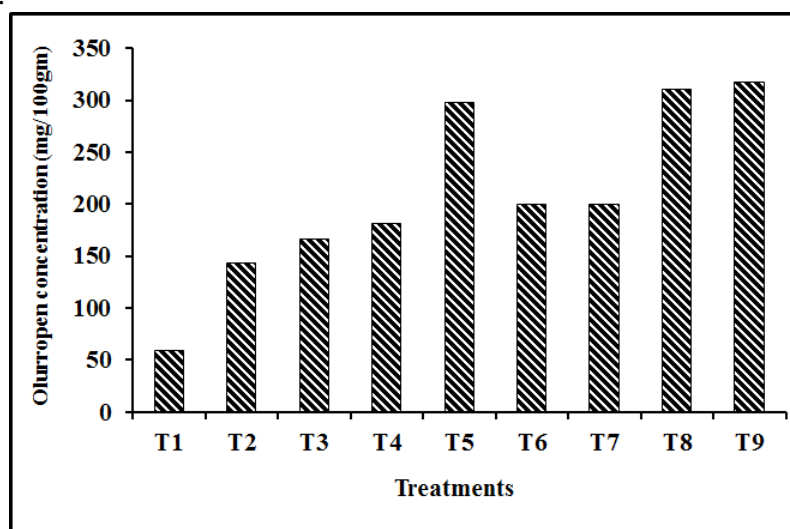


Fig. 4: Oleuropein concentration in olive leaves extract recorded with all treatments.

4. DISCUSSION

It is clearly noticed that, using bubbler 100 l/h and applying the deficit irrigation regime DIR of 75 % ETc. with 4 additional doses of urea 400 gm/tree is beneficial for the olive tree vegetative growth and also fruit yield production, compared with the control treatment T1 and other treatments that apply DIR 50 % ETc. by using dripper. As far alternate bearing index "ABI", the recorded value of ABI decreased with all treatments, compared with T1. On the other hand, Oleuropein concentration in the olive leave also increased when applying DIR of 75 % ETc. by using bubbler irrigation system with additional doses of urea 400 gm/tree, compared with the control treatment T1. These results may due to that, bubbler system are particularly suited to irrigation fruit trees, specially the old olive trees (15 years), that has a deep root zone, in which a standpipe bubble can be installed alongside each tree. The irrigation water delivered by each bubbler is a big quantity in a short time distributed uniformly by filling small level basins, surrounded by low ridges, with equal quantities of water, and the ability to more precisely apply nutrients to the tree, made the bubbler system has an important role to develop deep root hairs, which improve all plant physiological activities, compared with drip irrigation system in which, the root development under drip irrigation is constrained to the wetted soil volume by the emission points, thereby roots are concentrated near the soil surface and their length is decreased, and slow down the plant physiological activity. DIR is an appropriate method of irrigation for olive trees that does not necessarily have any negative impact on fruit yield if applied during uncritical phonological stages with the correct amount of nitrogen fertilizer. So that, it's recommended that, using bubbler of 100 l/h and apply DIR 75 % ETc. with 1.6 kg urea distributed in 4 doses during March will gave the highest level of vegetative growth and Oleuropein concentration in the olive leaves.

5. CONCLUSION

Conclusion from the previous results can be summarized as follows:

- 1- Managing the quantity and timing of irrigation and fertilization with olive trees, increases the yield of Oleuropein through enhancing the

physiological activity of olive leaves, that will increase concentration of the phenolic compounds specially Oleuropein on the olive leaves, and also increase the amount of vegetative growth that can be harvested during trees pruning. This is considered as an added value to the olive tree.

- 2- The best management plan for olive trees fertigation depends on the ultimate goal of production, whether that be for olive fruits or olive oil or newly for olive leaves. For the purpose of olive leaves production, the highest values of vegetative growth and olive leaves content's level of oleuropein achieved at DIR of 75% ETc. by using bubbler with additional 4 doses of urea (400gm), as in T9.
- 3- The availability of nitrogen considered the most important factor influencing primary and secondary metabolism syntheses in plants. A possible improvement of physiological performance of olive trees by increasing nitrogen levels.
- 4- When applying deficit irrigation regime of 75% ETc. a 25% cut in irrigation water use could be achieved without negative impacts on fruit yield production.
- 5- Olive leaves are a by-product of olive tree cultivation, available throughout the year; collected during pruning, harvest, and oil extraction. This biomass can be used as a cheap source of high added-value phenolic compounds; especially Oleuropein. It is a bioactive ingredient could be used in medicines, pharmaceuticals, cosmetics and to improve the shelf life of foods. Thus, valorization of olive leaves should be encouraged for replying higher demand of olive leaves for the pharmaceutical purposes inside Egypt and exporting outside.
- 6- More investigation effort must be carried to study the effect of DIR regime on the quality and quantity of olive oil production, and also Oleuropein concentration of olive leaves at different age and stages of crop cycle.

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الملخص العربي

إدارة الري التسميدي لتعظيم محتوى الأولوروبين في أوراق الزيتون

د. فتحى عبد الحليم عبد الهادى^١ ، د. احمد عبد العاطى حسين^٢ و د. أحمد عبد الرشيد عبد المنصف^٢

إجرى هذا البحث على أشجار الزيتون صنف شمالى عمر ١٥ عام ، خلال ثلاث مواسم متتالية ٢٠١٥ حتى ٢٠١٧ فى مزرعة خاصة على بعد ٣٢ كم من طريق القاهرة الأسكندرية الصحراوى ، فى أرض رملية على مسافات ٥ * ٥ م . بهدف التقليل من حدة ظاهرة تعاقب الحمل وزيادة النوات الخضرية ومضاعفة محتواها من مادة الأولوروبين (نوع من الفينولات متعددة الاستخدامات خاصة فى المستحضرات الطبية) ، عن طريق دراسة تطبيق نظام مقترح لإدارة الري التسميدى لأشجار الزيتون يعتمد على خفض كميات ماء الري لأقل من المعدل الموصى به وهو " ٢٥٢٦ م^٣ / فدان / سنه " إلى ٧٥ % (١٨٩٥ م^٣ / فدان) و ٥٠ % (١٢٦٣ م^٣ / فدان) ، خاصة فى مراحل موسم النمو غير الحرجة وذلك باستخدام نظامين للري ، النظام الاول (بابلر ١٠٠ ل/س) ، و الثانى (نقاط ٨ ل/س) ، مع إعطاء النبات ٤ جرعة إضافية من اليوريا بمستويين (٢٠٠ جم/شجرة) و (٤٠٠ جم/شجرة) فى صورة محلول حقتا من خلال شبكة الري بتركيز (١ كجم / ١٠٠ لتر) فى شهر مارس مع الجرعات المقررة ، لتحفيز الأشجار على زيادة النوات الخضرية خاصة فى السنوات التى يتوقع فيها حدوث ظاهرة تعاقب الحمل ، وتأثير ذلك على النمو الخضرى و كمية محصول الثمار و دليل تعاقب الحمل إلى جانب محتوى الأوراق ونواتج الخف والتقليم من مادة الأولوروبين ، ويمكن تلخيص نتائج الدراسة خلال ثلاثة مواسم كما يلى:

- ١- أعلى قيمة لعدد الأفرع الجديدة كانت ١٧.٧ و ١٦.٧ سجلت مع المعاملة ٩ و ٨ عند خفض ماء الري بنسبة ٧٥ % عن البخر نتج واطافة ٤ جرعات من اليوريا بمقدار ٢٠٠ جم و ٤٠٠ جم من خلال بابلر ١٠٠ ل / ساعة.
- ٢- أعلى قيمة لطول الأفرع الجديدة كانت ٢٧.٥ و ٢٦.٥٨ سجلت مع المعاملة ٩ و ٥ عند خفض ماء الري بنسبة ٧٥ % و ٥٠ % عن البخر نتج على الترتيب مع اضافة ٤ جرعات من اليوريا بمقدار ٤٠٠ جم من خلال بابلر ١٠٠ ل / ساعة.
- ٣- أعلى قيمة لقطر الأفرع الجديدة كانت ٢.٦٥ و ٢.٥٧ سجلت مع المعاملة ٩ و ٥ عند خفض ماء الري بنسبة ٧٥ % و ٥٠ % عن البخر نتج على الترتيب مع اضافة ٤ جرعات من اليوريا بمقدار ٤٠٠ جم من خلال بابلر ١٠٠ ل / ساعة.

١ باحث بقسم نظم الهندسة الحيوية، معهد بحوث الهندسة الزراعية، مركز البحوث الزراعية، الدقى ، الجيزة ، مصر.
٢ باحث بقسم الري والصرف الحقلى، معهد بحوث الهندسة الزراعية ، مركز البحوث الزراعية، الدقى ، الجيزة ، مصر.

- ٤- أعلى قيمة لعدد الأوراق على الأفرع الجديدة كانت ٣٥.٥ و ٣٣ سجلت مع المعاملة ٩ و ٥ عند خفض ماء الري بنسبة ٧٥% و ٥٠% عن البخر نتج على الترتيب مع اضافة ٤ جرعات من اليوريا بمقدار ٤٠٠ جم من خلال بابلر ١٠٠ ل /ساعة ، بينما كانت أقل قيمة لعدد الأوراق على الأفرع الجديدة ٢٥.٣ سجلت مع المعاملة ١ خلال موسم ٢٠١٧.
- ٥- أعلى قيمة لمساحة الأوراق كانت ٥.٢١ و ٥.١١ سم^٢ سجلت مع المعاملة ٩ و ٥ عند خفض ماء الري بنسبة ٧٥% و ٥٠% عن البخر نتج على الترتيب مع اضافة ٤ جرعات من اليوريا بمقدار ٤٠٠ جم من خلال بابلر ١٠٠ ل /ساعة ، بينما كانت أقل قيمة لمساحة الأوراق على الأفرع الجديدة ٣.٦٩ سم^٢ سجلت مع المعاملة ١ خلال موسم ٢٠١٧.
- ٦- أعلى قيمة لمحصول الثمار كانت ٥٢.٨٤ كجم سجلت مع المعاملة ٩ عند خفض ماء الري بنسبة ٧٥% عن البخر نتج مع اضافة ٤ جرعات من اليوريا بمقدار ٤٠٠ جم من خلال بابلر ١٠٠ ل /ساعة ، بينما كانت أقل قيمة للمحصول ٤٤.٦١ كجم سجلت مع المعاملة ١ خلال موسم ٢٠١٧ ، من ناحية اخرى ، كانت أعلى قيمة لمحصول الثمار ٣١.١٦ كجم سجلت مع المعاملة ٩ وأقل قيمة للمحصول كانت ١٥.٦١ سجلت مع المعاملة ١ خلال موسم ٢٠١٥. حيث كانت الأشجار فى طور الحمل الخفيف فى ذلك العام.
- ٧- أعلى قيمة لمؤشر تعاقب الحمل كان ٢٥٦,٠ سجلت مع المعاملة ١ وأقل قيمة كانت ١٣١,٠ سجلت مع المعاملة ٩ ، كما أن تطبيق الخفض المقترح لكميات ماء الري سواء ٧٥% أو ٥٠% مع اضافة ٤ جرعات من اليوريا خلال شهر مارس أدى الى إنخفاض مؤشر تعاقب الحمل مقارنة بالمعاملة الحاكمة ١.
- ٨- أعلى قيمة لتركيز الأولوروبين فى الأوراق ونواتج الخف كانت ٣١٦.٥٩ مجم / ١٠٠ جم وزن جاف سجلت مع المعاملة ٩ وأقل قيمة كانت ٥٨.٥٦ مجم / ١٠٠ جم وزن جاف سجلت مع المعاملة الحاكمة ١.
- ٩- يؤدى تطبيق نظام ادارة الري التسميدى المقترح إلى ما يلى:-
 - تلبية الطلب المتزايد على أوراق الزيتون محليا ولأغراض التصدير.
 - زيادة العائد من اشجار الزيتون نتيجة تسويق النواتج الثانوية بأسعار قد تفوق محصول الثمار والزيت.