ENERGY CONSUMED, WATER PRODUCTIVITY AND VITAMIN (C) CONCENTRATION OF ORANGE CROP UNDER DIFFERENT IRRIGATION SYSTEMS

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ABSTRACT

Food and water consider the key to life. The aim of this study is to increase water productivity and enhancing the quality of the orange crop (Citrus sinensis Osbeck L.). To a chive that aim, four irrigation systems (conventional surface irrigation (SI), furrow irrigation (FI), surface drip irrigation (SDI) and subsurface drip irrigation (SSDI) under heavy soil (clay) at the north of delta Egypt. Soil water content (SWC), soil temperature and soil EC were measured during the growing season under irrigation systems. At the end of the growth season yield and vitamin C were measured for three randomized samples for each treatment. Also, the energy consumed was estimated for each irrigation system. The results shown that the highest values of soil water content at depth 10 cm and along the distance of 200 cm from steam of tree were achieved under SSDI and SDI which increased SWC by 1.7 % and 1.2 % than SI, respectively and the lowest values of SWC was obtain at FI which decreased by 13.2 % than SI, while, at depth 50 cm the highest values of SWC were under SI, applying FI, SSDI and SDI systems decreased the SWC by 16.9 %, 14.7 % and 7.3% than FI, respectively. At depth 100 cm the highest value of SWC was 31.9 (cm^3 cm^3) under FI، which increased by 40.2 % than SI, followed by SSDI and SDI by values 27.9% and 7.7%, respectively. Moreover, the results shown that, subsurface drip irrigation system (SSDI) gave the highest orange yield (6.1 Mg fed^{-1}), followed by the surface drip irrigation (SDI) system of 6 Mg fed^{-1}, while the lowest yield was obtained under SI system (5.2Mg fed^{-1}). FI resulted in the higher yield compared with SI (5.4 Mg fed^{-1}) but at the same time, the lower yield as compared with both the SSDI and SDI systems. On the other hand, SSDI system increased the yield by 40.1 %, followed by SDI by 25.8 % and FI by 8.6 % than SI.

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The highest concentration of vitamin C was 23.4 mg / 100g under SSDI, followed by values 16.83 and 14.52 (mg/ 100g) under SDI and FI, respectively and the lowest concentration was 12.11 under SI. The highest value of consumptive energy was 1044.4 (kwh / fed. season) achieved under SI, followed by 696.3 (kwh / fed. season) under FI and the lowest values were 613.1 and 642.3 (kwh / fed. season) under SSDI and SI, respectively.

KEYWORDS: *Furrow irrigation, surface irrigation, drip irrigation, subsurface drip irrigation and soil water content.*

INTRODUCTION

Water and nutrients are the main resources for crops production. The food production will not meet the demands of population in Egypt according to the shortage of water **(Mancosu, et. al, 2015)** and the overpopulation on the other hand. In addition, the excessive use of fertilizers or nutrients will cause environmental problems beside of it requires expensive costs. Moreover, the increases of nutrients in contents of crops would cause potential hazard for human **(Alfthan et al., 2015) and (Nganchamung and Robson, 2017).**

Recently, the world pay attention not only for the yield but also for the contents and quality of crops. One of the most important crops in the world is citrus. It can be eating without cooking and it may be used in different products and manufactures of medicine. The most important content of citrus is vitamin C. The increase of yield and quality of crop needs to use the appropriate amount of water and fertilizers.

The traditional surface irrigation system is the common irrigation system in Egypt and consumes more amount of water, while the pressurized irrigation systems play the main role in applying the water and nutrients by suitable amounts. The drip irrigation system is considered the more efficient irrigation system where its efficiency ranges from 90% to 95% **(Slack, et. al, 2017).**

The furrow irrigation is the most common method of surface irrigation. It is noted that in order to achieve uniform wetting of the soil water flow fed into the furrows is increased, while the excess water is collected at the end of the furrow, and then reset the bleed water collection network. The dependence of uniform wetting of the field on the length of the furrow, the water flow, soil fertility, and slope areas. Noticed, that the loss of water in the discharge of up to 40% of the irrigation norms, especially characteristic fields slope steeply. It is noticed that the loss of water in the discharge of up to 40% of the irrigation norms, especially characteristic for fields with steep slopes. Blow-off water washes away the fertile soil from fertilizers applied to improve soil fertility and crop yields. It is shown that as a result of irrigation erosion are reduced not only agricultural yields but also the quality of products **(Manabaev, et. al, 2015).**

The drip irrigation system is the frequent slow application of water onto the land surface or into the root-zone of crop. It can relieve low operating pressures problem at the end of the lateral lines **(Mansour, 2013).**

The subsurface drip irrigation (SSDI) system offer some advantages over other types of irrigation systems for specialty crop production, including water savings, improved trafficability, and a drier canopy **(Steele, et. al, 1996).** Also, subsurface drip irrigation offers many advantages for the management of water and nutrients **(Camp, et. al, 1999).** Subsurface drip irrigation system is a new technique of drip irrigation system and increasingly being used in agriculture in attempts to use the available water more efficiently **(Kandelous, et. al, 2011).** the drippers lied under soil surface by 15-30 cm for vegetable and 60 cm for trees **(Slack, et. al, 2017).**

The aim of this research is to study the effects of irrigation systems on yield, water productivity (WP) and the concentration of vitamin C for the orange crop.

MATERIAL AND METHODS

Experimental site

The experimental field is located at Faculty of Agriculture, Benha University in the north of Egypt at latitude 31.223106 N longitude 30.357098 E an altitude15 m above sea level. The climate of this area is BWh (hot desert climates) according to Köppen climate classification **(Köppen, 1936).** The meteorological data were recorded by metrological station (iMatios), which constructed in the experimental site. The area of the experimental work was 2100 m^2 and the distance between the rows of trees was 4 m and it was 5 m between trees at row. The age of orange trees was 15 years at the beginning of the experiment. It was irrigated by surface irrigation before the period of this experimental were (2017 – 2018).

Four soil samples were collected from depths of 0-30, 30-60, 60-90 and 90-120 and analyzed laboratory according to **Klute (1986)** and **Page et al. (1982)**. The soil properties were shown in Tables (1 and 2).

Table (1). Soil physical properties.

Property	Soil depth (cm)			
	0-30	30-60	60- 90	90-120
Particle size distribution				
Corse Sand %	19.81	21.43	20.7	21.31
Fine sand %	2.64	2.07	1.98	2.17
Silt %	28.94	27.18	30.98	29. 45
Clay %	48.61	49.32	46.34	47.07
Textural class	Clay	Clay	Clay	Clay
Saturation percentage %	70	79	78	80.1
Field capacity %	33.42	37.19	36.85	35.9
Welting point %	15.8	17.98	18.04	18.23
Total available water, % TAW	17.62	19.21	18.81	17.67
Bulk density (Mg m^{-3})	1.11	1.13	1.19	1.12
Particle density (Mg m^{-3})	2.14	2.3	2.2	2.16
Total porosity %	49.12	50.1	45.61	46.21

Table (2). Soil chemical properties.

Property		Soil depth (cm)			
		0-30	30-60	60- 90	90-120
pH		7.12	7.83	8.04	8.39
EC. (dS m^{-1})		3.54	3.43	3.8	2.2
Cations (mmol l^{-1})	Na^+	22.0	15.1	20.0	15.9
	K^+	0.7	0.6	0.7	0.6
	Ca^{++}	6.5	5.0	7.1	6.0
	Mg^{++}	3.0	2.1	5.0	6.5
Anions (mmol l^{-1})	CI^-	20.0	15.8	23.0	19.0
	CO_3^{--}	5.0	5.0	5.1	7.7
	HCO_3^-	9.0	10.9	9.0	8.9
	SO_4^{--}	1.8	8.9	4.3	6.6
Total nitrogen %		0.12	0.11	0.07	0.09
Available K (mg kg^{-1})		401.3	386.7	374.5	365.3
Available P (mg kg^{-1})		46.4	43.1	42.2	39.3

Irrigation systems

The area of the experiment was divided into 4 equal parts. Four irrigation systems i.e. conventional surface irrigation (SI), furrow irrigation (FI), surface drip irrigation (SDI) and subsurface drip irrigation (SSDI) systems were used for irrigating the orange crop during the period from 2017 until 2018. The specifications of the drip irrigation system were: the emitters were inline 8 ($l\ h^{-1}$) discharge at 0.8 bar and the number of emitters per tree was 4. The lateral lines under subsurface drip irrigation system were lied under soil surface by 60 cm according to **Slack, et. al, (2017).**

Irrigation schedule

Evapotranspiration was estimated by Benman-Monteith equation and crop factor was selected from FAO Tables according to Allen (2008). Total Available Water (TAW) is the water content at field capacity minus the water content at wilting point multiplied by root depth and a specific gravity of soil as shown in Table (1). The applied irrigation depth was estimated by dividing the TAW by the efficiency of the irrigation system and leaching requirements. The assumed values for efficiency for SI, FI, SDI, and SSDI were 60%, 70%, 90%, and 95%, respectively. The estimated leaching requirement according to (**Rhoades, 1974**).

Measuring of soil water content, soil EC and soil temperature

Four soil profiles under trees, 50 cm width, 200 cm long and 100 cm depth were done for each irrigation system. 6 points and 9 layers (depths of 10, 20, 30, 40, 50, 60, 70, 80 cm) were selected for measuring the soil water content as shown in Figures (1, 3 and 5).

Ten locations in the distance between rows of trees were been selected (0, , 25, 50, 75, 100, 150, 200, 300, 400 and 500 cm) away from tree at depths of 10, 50 and 100 cm of soil surface, for measuring SWC, soil EC and soil temperature were measured by wet sensor and HH2 device three times during the growing season. Surfer 15 and OrgingLab 9 programs were used for drawing and analyzing the data as shown in Figures (9, 10 and 11).

Yield and water productivity

The crop was harvested at full maturity stage for all replicates (3 trees) of each treatment. The water productivity is the yield (kg fed^{-1}) divided by the total water ($m^3\ fed^{-1}$) **(Molden et. al., 2010) and (Farag, 2018).**

Energy consumed

The used electrical motors were 3 kW under drip irrigation system (SDI and SSDI) and 15 kW under surface irrigation systems (SI and FI). The consumptive energy was estimated by multiplying the number of operating hours by electrical consumed energy in hour (kWh). The average price of electrical energy for each 1 kWh during the period of the experiment was 0.75 Egyptian pound during the experimental period.

Statistical analysis

The experimental design was a randomized complete block design (RCBD) with 3 replicates. The results of yield, water productivity and Vitamin C concentration of orange were analyzed by using ANOVA one way to show the differences between the treatments at sig. 0.05. The SPSS program version number 25 was used for carrying out this analysis.

RESULTS AND DISCUSSION

I.Soil water distribution under the studded irrigation systems

I.1 Surface irrigation system

Data in Figures (1 and 2) show the soil water distribution in different layers of soil profile under surface irrigation system.

The SWC increased in the vertical direction from 24.4 (cm^3 cm^{-3}) at the soil surface to 42.83 (cm^3 cm^{-3}) at a depth of 80 cm. The SWC at the surface increased with the distance from the tree to 45 cm (30.8 cm^3 cm^{-3}) beyond which it decreased to 25.9 (cm^3 cm^{-3}) at 200 cm from the tree. SWC increased from 34 and 38.7 (cm^3 cm^{-3}) near the tree to 37 and 40.4 (cm^3 cm^{-3}) at depths of 20 and 30 cm at distance of 80 cm from tree. Within the depth of 40 cm to 80 cm, the changes in soil water content were very small and the soil water content increased in a horizontal direction away of the tree. Where d 10, d 20, d 40, d 60 and d 80 are the depths of soil layers at 10, 20, 40, 60 and 80 cm.

I.2 Furrow irrigation system

Data in Figures (3 and 4) show the soil water distribution in different layers of soil profile under furrow irrigation system. The SWC increased from 25.48 (cm^3 cm^{-3}) at the surface to 40.9 (cm^3 cm^{-3}) at a depth of 80 cm, the percentage of increase in soil water content with the depth decreased with increasing the depth from surface to 80 cm depth. The difference in SWC between the upper layers were about 10.35 and 4.27 and at lower layers -0.83 and -0.05 ($cm^3\ cm^{-3}$). SWC increased in the horizontal direction from tree to the next tree on the row. On the other hand, SWC increased in the horizontal direction from tree at depths of 0, 30, 40, 50, 60, and 70 cm from soil surface but it decreased at depths of 10, 20 and 80 cm from the soil surface as shown in Fig. (3 and 4).

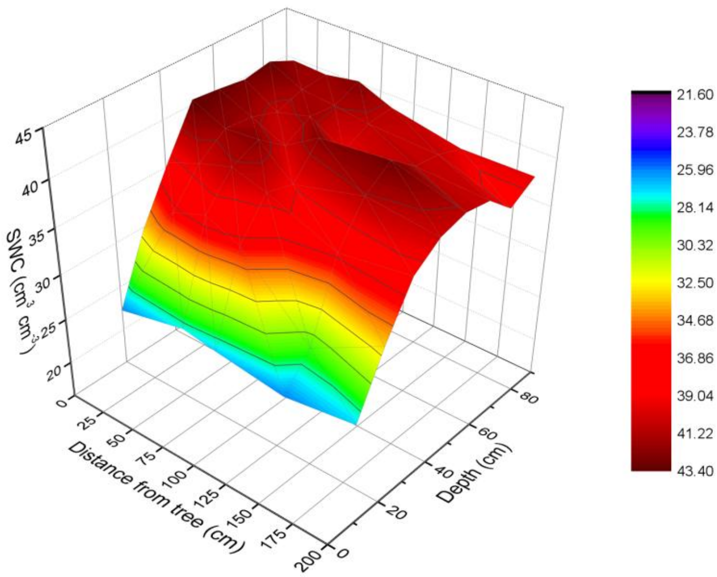

Fig. (1). The soil water content distribution under surface irrigation system.

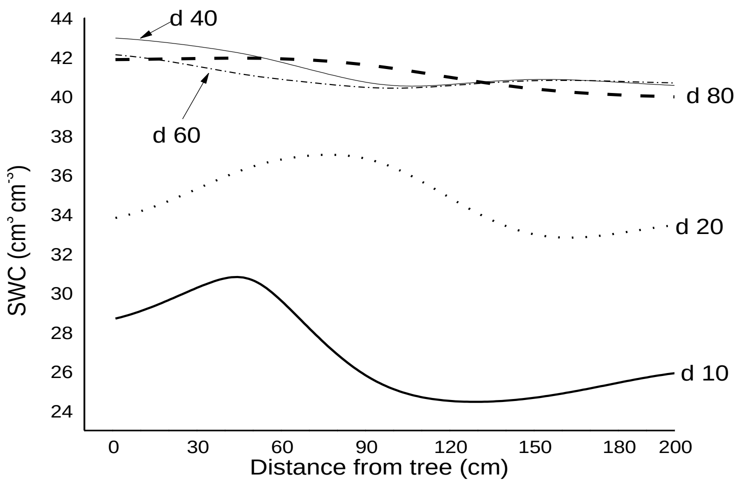

Fig. (2). The changes in soil water content at different depths for a radial distance of 200 cm from the tree under surface irrigation.

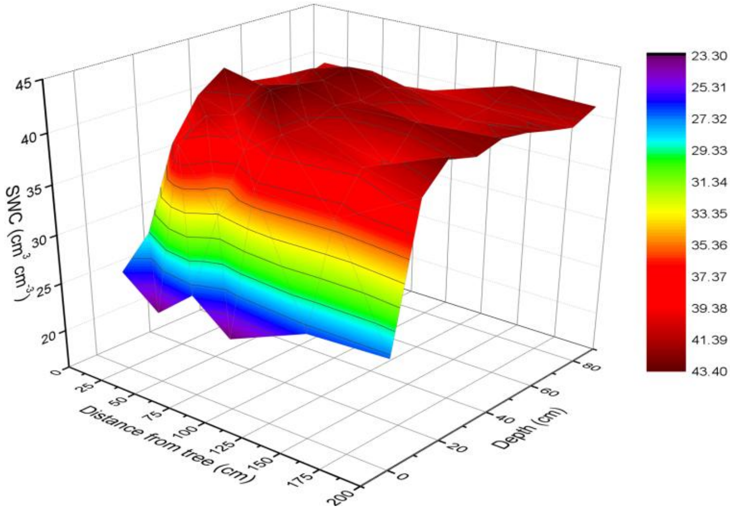

Fig. (3). The soil water content distribution under furrow irrigation system.

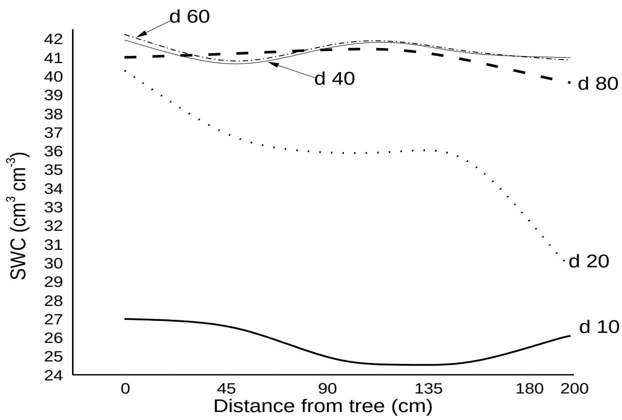

Fig. (4). The changes in soil water content at different depths for radial distance 200 cm from tree under furrow irrigation system.

SWC increased in the vertical direction from 24.5 (cm^3 cm^{-3}) at surface to 42.83 (cm^3 cm^{-3}) at a depth of 80 cm. SWC gradually decreased with the distance from tree up to 200 cm. SWC decreased from 27 and 41 (cm^3 cm^{-3}) near the tree to 26 and 29.8 (cm^3 cm^{-3}) at a distance of 200 cm from tree at soil surface and 20 cm depth, respectively. Within the depth of 40 cm to 80 cm the changes in SWC were very small and it decreased in horizontal direction away of tree as shown in Figures (3 and 4).

I.3 Surface drip irrigation

The data in Figures (5 and 6) show the soil water distribution in different layers of soil profile under surface drip irrigation system. The SWC increased in the vertical direction from 26.25 (cm^3 cm^{-3}) at surface to 41.7 (cm^3 cm^{-3}) at a depth of 80 cm. The SWC at surface increased from 26.75 (cm^3 cm^{-3}) near tree to 31.8 (cm^3 cm^{-3}) at horizontal distance of 60 cm thereafter it decreased to 25.7 (cm^3 cm^{-3}) at a 150 cm distance beyond witch it gradually increased to 26.4 (cm^3 cm^{-3}) at distance of 200 cm from tree. The SWC increased from 34 and 38.7 (cm^3 cm^{-3}) near the tree to 37 and 40.4 (cm^3 cm^{-3}) at a distance of 80 cm at the depths 20 and 30 cm, respectively. Within the depth of 40 cm to 80 cm the changes in SWC were very small and it increased in horizontal direction away from the tree as shown in Figures (5 and 6).

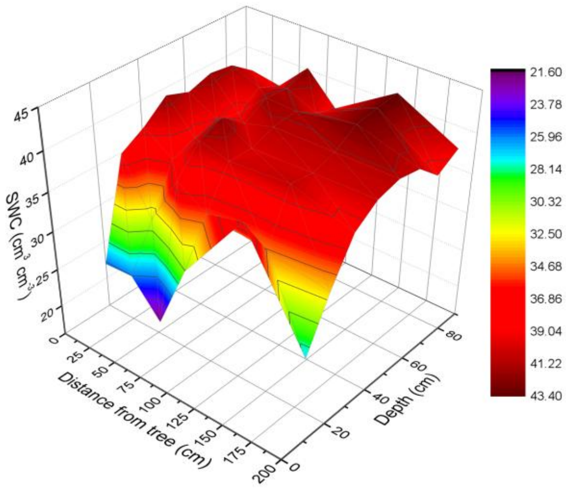

Fig. (5). The soil water content distribution under surface drip irrigation system.

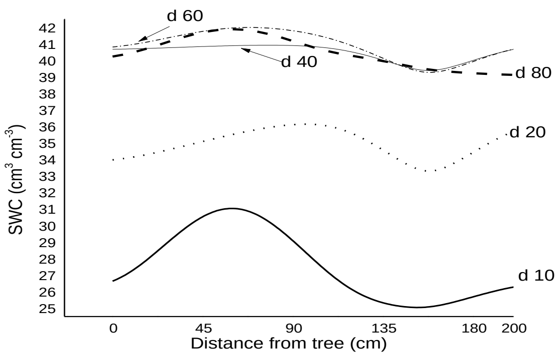

Fig.(6). The changes in soil water content at different depths for radial distance 200 cm from tree under surface drip irrigation system.

I.4 Subsurface drip irrigation

The data in Figures (7 and 8) show the soil water distribution in different layers of soil profile under subsurface drip irrigation system.

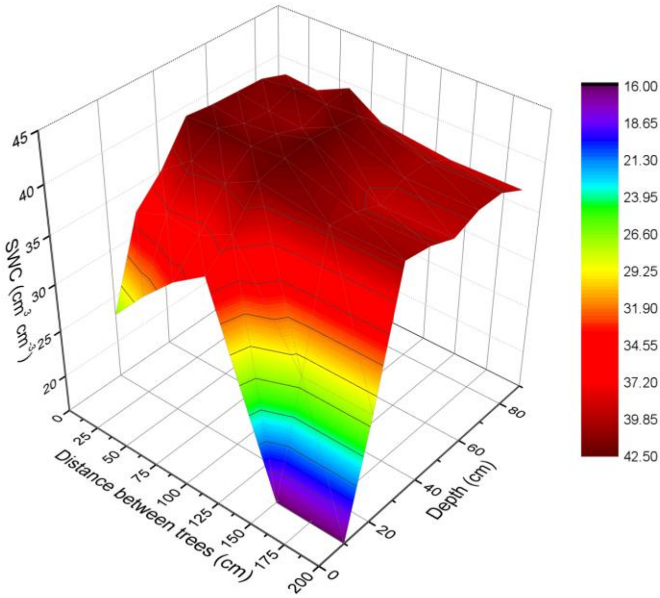

Fig. (7). The soil water content distribution under subsurface drip irrigation system.

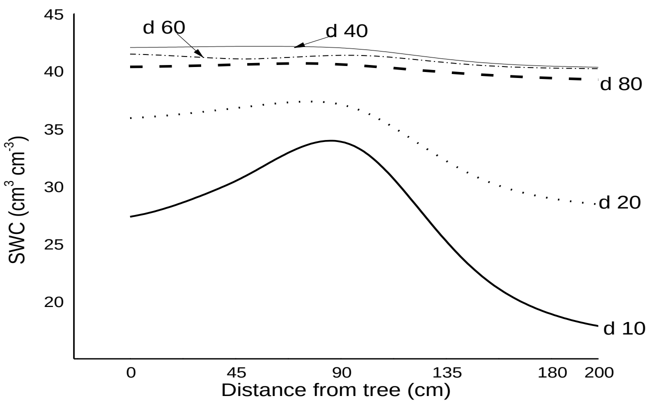

Fig.(8). The changes in soil water content at different depths for radial distance 200 cm from tree under subsurface drip irrigation system.

The SWC increased from 27.02 at soil surface to 40.84 ± 0.47 (cm^3 cm^{-3}). SWC decreased in the radial direction away from tree. The mean values of

SWC in the distance from tree to 200 cm for the upper layers were ± 5.4 and ± 3.32 (cm^3 cm^{-3}) at depths of 10 and 20 cm respectively, that were higher than the changes at the lower soil layers, that ranged from 0.49 to 0.85 (cm^3 cm^{-3}) at depths of 30 to 80 cm, respectively.

II.Relationship among SWC, soil electrical conductivity (EC_{soil}) and soil temperature (T_{soil}) under different soil depths

The results of average changes of SWC, EC_{soil} and T_{soil} along the distance between rows of trees (500 cm) before irrigation at depths of 10, 50 and 100 cm of soil surface are shown in Figures. (9,10 and 11).

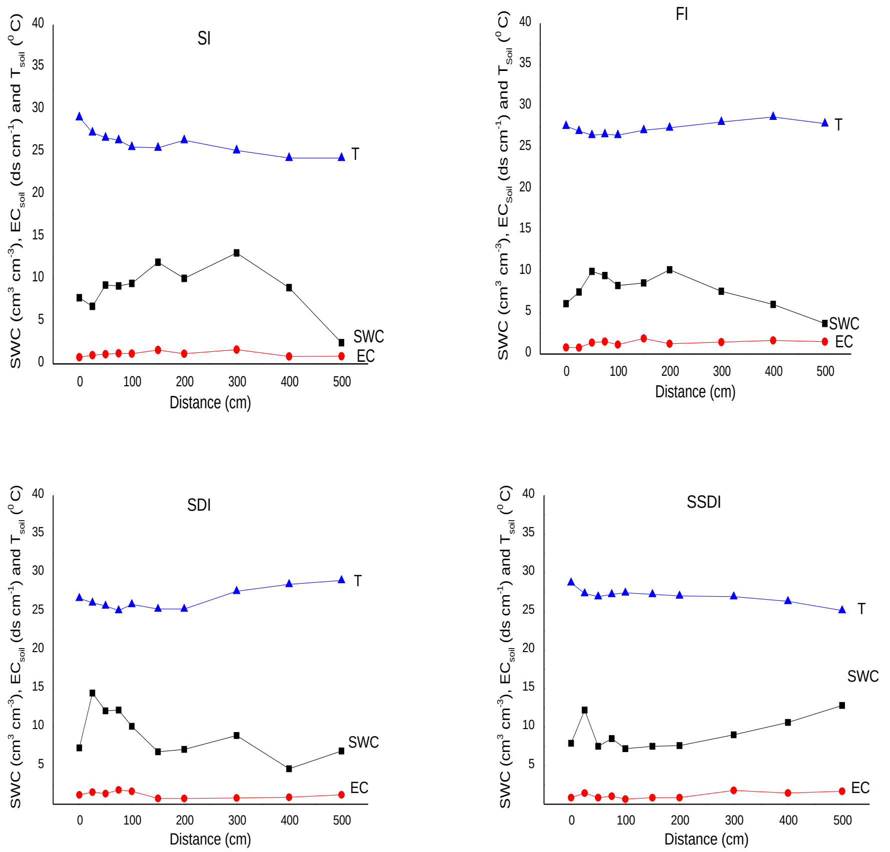

Fig. (9). The changes in SWC, soil EC and soil temperature under different irrigation systems at a depth of 10 cm from soil surface.

The results show that the highest values of SWC at depth 10 cm and along the distance of 200 cm from steam of tree were achieved under SSDI and

SDI which increased SWC by 1.7 % and 1.2 % than SI, respectively and the lowest values of SWC was obtain at FI which decreased by 13.2 % than SI, while, at depth 50 cm the highest values of SWC were under SI, applying FI, SSDI and SDI systems decreased the SWC by 16.9 %, 14.7 % and 7.3% than FI, respectively. At depth 100 cm the highest value of SWC was 31.9 (cm^3 cm^{3}) under FI، which increased by 40.2 % than SI, followed by SSDI and SDI by values 27.9% and 7.7%, respectively. Generally, the increase in SWC was associated with increase in soil EC which means that, increasing soil EC is duo to the increase of EC of irrigation water as shown in Figures (9, 10 and 11).

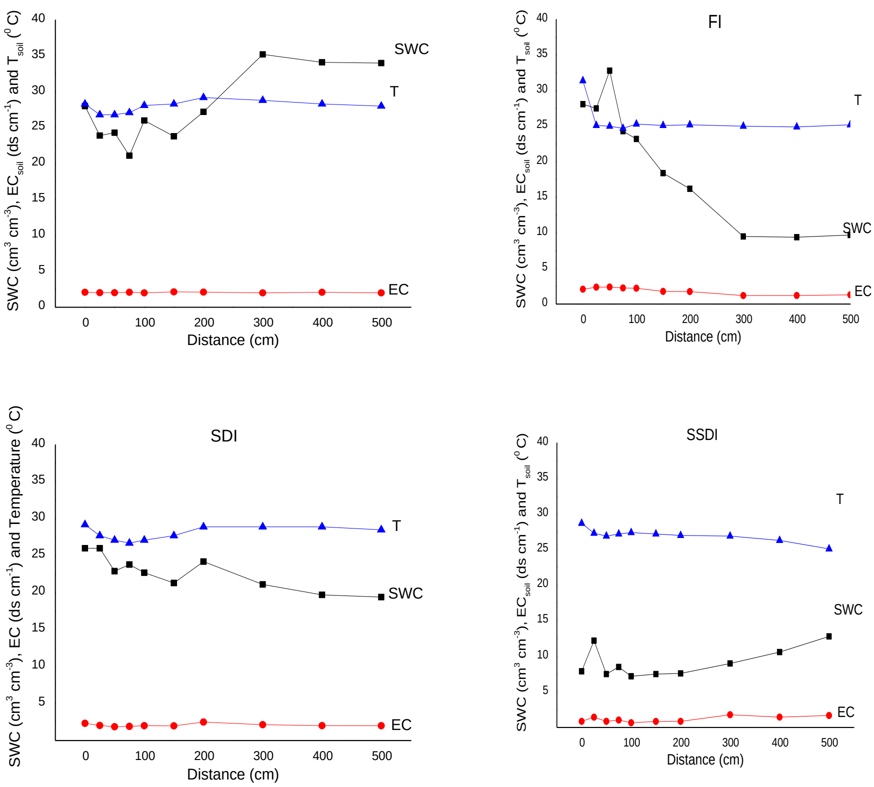

Fig. (10). The changes in SWC, soil EC and soil temperature under different irrigation systems at a depth of 50 cm from soil surface.

III. Irrigation water applied

The total applied irrigation water for each treatment is shown in Table (3).

Table (3). The applied irrigation water, WR

Irrigation water applied	season	SDI	SSDI	FI	SI
WR (m^3/fed season)	2017	1414.4	1350.1	2333.3	3500.0
	2018	1478.44	1411.24	2333.33	3500.00
WR (m^3/tree season)	2017	6.7	6.4	11.1	16.7
	2018	7.04	6.72	11.11	16.67

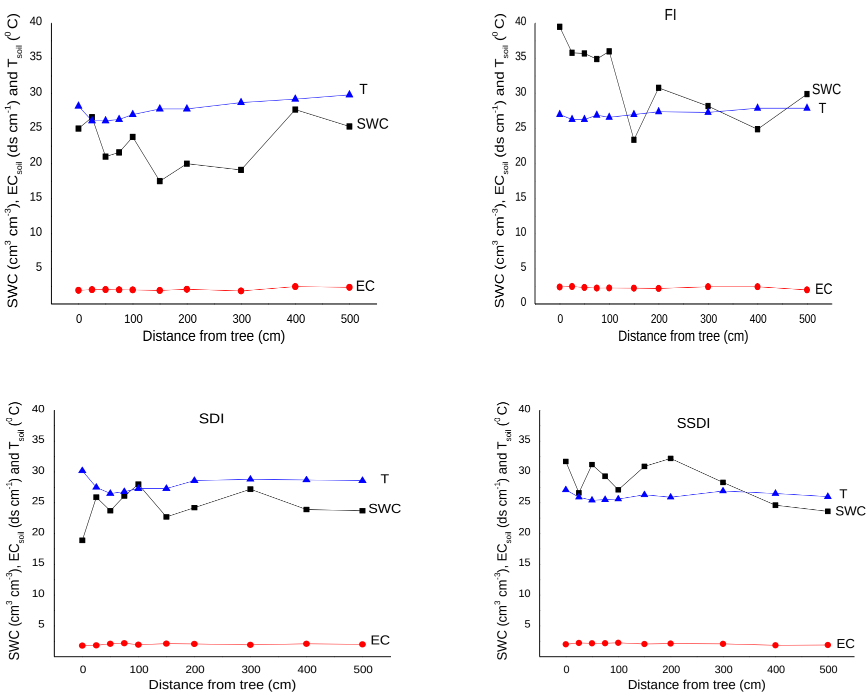

Fig. (11). The changes in SWC, soil EC and soil temperature under different irrigation systems at a depth of 100 cm from soil surface.

IV. Orange yield, and water productivity

The results of orange yield, water applied, water productivity and consumptive energy during the seasons 2017 and 2018 are shown in Table (4). The results show that, the average fruit yield differed significantly among the four irrigation systems. The highest orange yield was achieved under SSDI system (6.1 Mg. fed^{-1}) followed by SDI system (6 Mg fed^{-1}) while the lowest yield was obtained under the SI system (5.2 Mg fed. $^{-1}$). The FI resulted in higher yield compared with the SI system (5.4 Mg fed^{-1}) but at the same time, lower yield as compared with both SDI and SSDI systems. On the other hand, SSDI system increased the yield by 40.1 %, followed by SDI by 25.8 % and FI by 8.6 % as compared with SI.

Table (4). Yield, applied irrigation water and water productivity (WP) of the studied irrigation systems.

Irrigation systems	Yield (Mg fed^{-1})		WP (kg m^{-3})	
	2017	2018	2017	2018
SDI	4.96	6.97	3.1	4.7
SSDI	5.18	7.11	3.9	3.7
FI	5.20	5.54	1.7	2.4
SI	4.97	5.5	1.0	1.6

Moreover, the results show that the SSDI saved the applied irrigation water (60.5 %), followed by SDI (59 %) and FI (33%) as compared with SI system.

The highest values of WP were found under SDI (3.9 kg m^{-3}) followed by SSDI (3.8 kg m^{-3}), while, the lowest WP values were 2.05 and 1.3 (kg m^{-3}) under FI and SI systems, respectively. Moreover, the water productivity of orange crop under SSDI increased by 200 %, followed by SDI (192.3 %) and FI (57.7 %) as compared with SI system.

V. Vitamin C concentration

The results of vitamin C concentration in orange trees was shown in Fig. (12). The highest concentration of vitamin C was 23.41 (mg/ 100g) under SSDI, followed by SDI (16.83 mg/ 100g) and FI (14.52 mg/ 100g) and the lowest value was 12.11 under SI system.

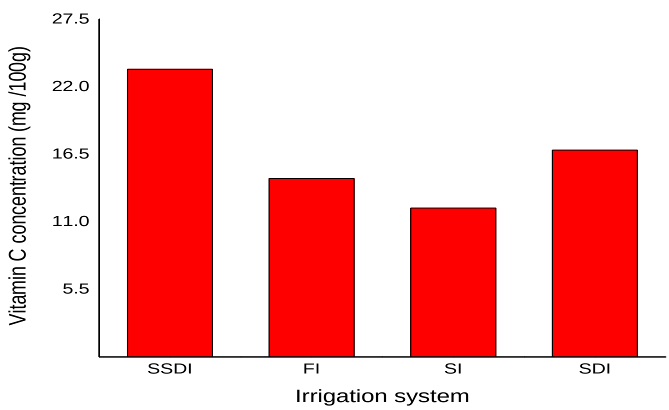

Fig.(12).Vitamin C concentration in orange fruits.

VI. Consumptive energy

The energy consumed during the seasons of 2017 and 2018 are shown in Table (5). The using of SSDI decreased the consumptive energy by 41.3%, followed by SDI (38.45 %) and FI (33.15 %) as compared with SI system.

The highest value of consumptive energy was 1305.5 (kWh / fed. season) achieved under SI, followed by 870.3 (kWh /fed. season) under FI and the lowest values were 766.35 and 802.85 (kWh/ fed. season) under SSDI and SDI, respectively.

Table (5). Energy consumed and water productivity of the different irrigation systems.

Irrigation system	Consumed energy (kWh)		Total consumed Energy (kWh/fed.season)		Total cost (LE /fed)		Energy saving (%)	
Year	2017	2018	2017	2018	2017	2018	2017	2018
SDI	3.73	3.73	785.1	820.6	588.8	615.5	39.9	37
SSDI	3.73	3.73	749.4	783.3	562.0	587.5	42.6	40
FI	18.65	18.65	870.3	870.3	652.8	652.8	33.3	33
SI	18.65	18.65	1305.5	1305.5	979.1	979.1	0	0

CONCLUSION

The soil water content distribution in soil, differed according to the irrigation system. SSDI and SDI achieved the highest values of SWC at a depth of 10 cm from soil surface, while, at a depth of 50 cm SI and FI systems gave the highest values of SWC. At a depth of 100 cm FI system achieved the highest value of SWC. The results of yield show that, subsurface drip irrigation system (SSDI) gives the highest orange yield, followed by the surface drip irrigation (SDI) system, while the lowest yield was obtained under SI system. FI resulted in the higher yield compared with SI system. The highest concentration of vitamin C was under SSDI, followed by values SDI and FI systems, respectively and the lowest concentration of vitamin C was under SI system. The SWC at nearest the soil surface was more effect on yield and vitamin (C) concentration. The using of SSDI decreased not only the consumptive energy by 41.3%, followed by SDI (38.45 %) and FI (33.15 %) as compared with SI system but also saved the applied irrigation water (60.5 %), followed by SDI (59 %) and FI (33%) as compared with SI system.

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الملخص العربي

استهلاك الطاقة والانتاجية المائية وتركيز فيتامين (C) لمحصول البرتقال تحت نظم ري مختلفة

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يعتبر الغذاء والماء اهم العناصر الضرورية للحياة ونقص الماء يحدث نقصا بالتبعية في الغذاء. لذا يهدف هذا البحث الي رفع الإنتاجية المائية لمحصول البرتقال. لإجراء ذلك تم استخدام اربعة نظم ري مختلفة (الري السطحي بالغمر – الري السطحي في خطوط – الري بالتنقيط السطحي – والري بالتنقيط تحت السطحي) في شمال الدلتا بالأراضي الثقيلة الطينية. تم عمل قطاعات في التربة تحت نظم الري المختلفة لتقدير المحتوي المائي بالتربة قبل الري وذلك بهدف معرفة التغير في المحتوي الرطوبي تحت نظم الري المختلفة التي تم استخدامها في الدراسة. أيضا تم قياس المحتوي الرطوبي للتربة وملوحة التربة وكذلك درجة حرارة التربة لدراسة العلاقة بينها. أيضا تم قياس انتاج المحصول من الثمار عند تمام النضج، وكذلك تم قياس نسبة فيتامين (C) في ٣ عينات عشوائية تحت كل نظام ري وتم حساب استهلاك الطاقة لكل نظام ري.

وقد اوضحت النتائج الأتى:

١. أعلي محتوي مائي عند عمق ١٠ سم ولمسافة ٢٠٠ سم من ساق الشجرة تحت نظامي الري بالتنقيط تحت السطحي وفوق السطحي بزيادة تراوحت بين ١,٧ % و١,٢ % عن الري السطحي التقليدي (الكنترول) علي التوالي وكان اقل محتوي رطوبي تحت نظام الري السطحي في خطوط. بينما عند عمق ٥٠ سم أسفل سطح التربة وجد ان اعلي محتوي رطوبي تحت نظام الري السطحي التقليدي وقد اتضح ان استخدام الري بالتنقيط تحت السطحي ادي الي انخفاض المحتوي الرطوبي عن الري السطحي بمقدار ٧,٣% يليه الري بالتنقيط السطحي ١٤,٧% بينما كان اعلي انخفاض في المحتوي الرطوبي تحت نظام الري السطحي في خطوط (١٦,٩%).

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اما عند عمق ١٠٠ سم من سطح التربة فقد اتضح ان اعلي محتوي رطوبي تحت نظام الري السطحي في خطوط (٣١,٩ سم^{٣} سم$^{-٣}$) حيث زاد المحتوي الرطوبي بمقدار ٤٠,٢ % عن الري السطحي التقليدي يليه الري بالتنقيط تحت السطحي بزيادة ٢٧,٩% عن الري السطحي التقليدي بينما رفع الري بالتنقيط السطحي المحتوي الرطوبي عن الري السطحي بمقدر ٧,٧% فقط.

٢. الري بالتنقيط تحت السطحي قد اعطي اعلي انتاجية بمتوسط (٦,١ ميجا جرام / فدان) خلال موسمي ٢٠١٧ و٢٠١٨، يليه الري بالتنقيط السطحي بإنتاجية ٦ ميجا جرم / فدان بينما اعطي الري السطحي التقليدي اقل انتاجية بمتوسط ٥,٢ ميجا جرام / فدان. ادي استخدام الري السطحي في خطوط الي رفع الانتاجية عن الري السطحي التقليدي حيث اعطي متوسط انتاج مقداره ٥,٤ ميجا جرام / فدان. وعموما ادي استخدام الري بالتنقيط تحت السطحي الي زيادة الانتاج بمقدار ٤٠,١ % يليه الري بالتنقيط السطحي بمقدار ٢٥,٨% يليه الري بالسطحي في خطوط ٨,٦ % عن الري السطحي التقليدي.

٣. اعلي تركيز لفيتامين (C) كان ٢٣,٤ مجم / ١٠٠ جم تحت الري بالتنقيط تحت سطحي ويليه كلا من الري بالتنقيط السطحي (١٦,٨٣ مجم / ١٠٠ جم) والري السطحي في خطوط (١٤,٥٢ مجم / ١٠٠ جم) بينما اعطي الري السطحي التقليدي اقل محتوي لفيتامين (C) (١٢,١١ مجم/ ١٠٠ جم)

٤. اعلي استهلاك للطاقة للفدان كان ١٠٤٤,٤ ك وات ساعة / موسم تحت نظام الري السطحي التقليدي يليه الري في خطوط بمقدار ٦٩٦,٣ ك وات ساعة / موسم واقل استهلاك للطاقة كان تحت نظامي الري بالتنقيط تحت سطحي بمقدار ٦١٣,١ ك وات ساعة / موسم والري بالتنقيط السطحي بقدار ٦٤٢,٣ ك وات ساعة / موسم.