DRIP IRRIGATION EFFECT ON SUNFLOWER OIL PRODUCTION IN THE SANDY SOIL.

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ABSTRACT

Effect of using different drip irrigation treatments on the properties' of extracted sunflower oil were investigated. The following resulted for two seasons (2013 and 2014) for the Surface and Sub Surface Drip Irrigation treatments (SDI and SSDI).Two sunflower varieties (Saka 53 and Giza102) were included in the treatments. For: season (2013) and variety Giza102: Ir. Systems, resp.: SDI and SSDI ETo %, From 50 to 100 yield kg/fed: 512 to 1055 oil % 30.4 to 43.4%. Corresponding results prevailed for the subsequent season for the yields and oil ratios by the two irrigation systems tested and sunflower varieties. In conclusion, the irrigation treatments have shown great effects on the oil yield and quality.

INTRODUCTION

Irrigation is the determinant factor in agriculture and water scarcity should be regarded for the maximum benefit in crops. Drip irrigation is one of the most important irrigation methods in the reclaimed lands of Egypt. There is a gap in the production of oil crops. It is necessary to expand the cultivation of these crops. The most important oil plant is probably sunflower. Water in Egypt should be saved to help preserve the environment from pollution of residue fertilizers used in agriculture, which may reach the ground water.

Under water scarcity, productivity of a crop can be improved significantly through drip irrigation by decreasing the leaching evaporation and surface runoff loses. El-Hendawy *et al.* (2008) Iterated that subsurface drip irrigation system offers great potential for increasing crop production in arid lands, because it reduces the consumption of the amount of irrigation water that gives way to the expansion of cultivated areas. Crop water models could be important decision-support tools for improved irrigation management**.** Irrigation interval may be increased the tolerant genotypes grown. Drip irrigation either at 100% of ETc or 80% ETc with 100% of RDF or 80% of RDF produced significantly higher seed yield, Sinha *et al.* (2017). Sunflower Helianthus annuus, L. Asteraceae (compostiae**)** is from the tropic crops and it produces economically in warm areas. Sunflower is characterized by ability to adapt to climate with high and low temperatures. As a result of improvement and the election of the varieties planted sunflower spread from subtropical areas in South America until the cold regions in Russia and Canada**.**

Sunflower plant is high resistant to drought, fast growing and absorbs water and nutrients efficiently (Gimenez, and Fereres 1986).The sunflower is important oil crop all over the world. Soviet Union, United States, Eastern Europe, Argentina, Southern European countries and South Africa planting it mainly oil crop (Kandil, 2000). Sunflower (Helianthus annuus L.), is an excellent source of heart-healthy unsaturated fats. It has become the second most important oil crop next to soybean in the world (FAO 2011). Sunflower is one of the most important oil crops and due to its high content of unsaturated fatty acids and a lack of cholesterol, the oil benefits from a desirable quality (Razi and Assad, 1999). Sunflower is rich of oleic monounsaturated fats, therefore considered as a useful source of dietary fat in preventing heart disease (Allman-farinelli *et al.*, 2005). Sunflower is preferable than the other oil crops such as cotton, rapeseed, and peanut, by the short period in the field, and high productivity of oil. The objective of this research is investigating the effects of water supply on the productivity of sunflower crop and oil properties. As irrigation is known to boost both growth and yield of sunflower**.**

MATERIALS AND METHODS

1) The study area and soil: Field experiments were carried out in the private farm near, (Wady Al Molak Ismailia وادى الملاك، اسماعيلية) Egypt, in sandy soil. Area of the experiment was 30 m x 24 m divided to 18 furrows of 150 cm width. Two successive summer seasons of 2013 and 2014 were included two varieties of Sunflower (Saka 53, Giza 102) were used in the experiments. Four irrigation water treatments were included (0.50, 0.60, 0.80, and 1.0 of the reference crop evapotranspiration). The drip irrigation system comprised GR dripper liner, 4 liter per hour capacity, diameter 16 mm with 30 cm emitters spacing. Surface Drip Irrigation (SDI) was used and the second was Subsurface Drip (SSDI) fixed at 15 cm depth under soil surface. Drip irrigation systems were set up according to the treatments presented in Fig (1). The soil of the experiment is classified as sandy soil. Soil analyses were made at the laboratory of Soil, Water and

Environment Res. Institute (S.W.E.R.I) before planting sunflower according to (Jackson, 1978), (Day, 1965) and (Black, 2000).

Climate data of (ETo) were obtained from local weather station at Ismailia, affiliated of the Central Laboratory for Agricultural Climate (C.L.A.C), Ministry of Agricultural and land Reclamation.

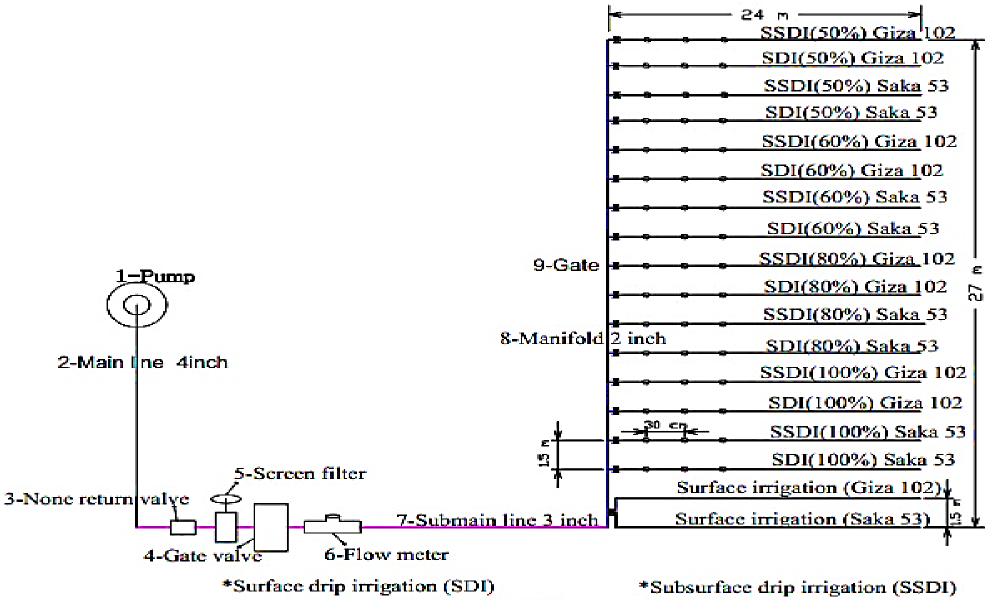

Fig.(1) Layout of the experimental area.

2) **Agricultural operations and irrigation water:** Two hybrid sunflower seeds (Saka 53 and Giza 102) were obtained from Oil Seeds Crop Dept., Field Crop Res. Inst., Agric. Res. Center, Giza, Egypt.

Table (1): Crop coefficient for sunflower crop.

Crop	$K_{c\,ini}$[1]	$K_{c\ mid}$	$K_{c\ end}$	Maxi crop height (h) (m)
Oil crops	0.35	1.15	0.35	
Sunflower		1.0-1.15[9]	0.35	2.0

FAO (2011) http://www.fao.org/nr/water/cropinfo_sunflower.html

Table (2): Observed crop coefficient for sunflower crop and diet.

Crop K_c	$K_{c\ Initial}$	$K_{c\ Develop}$	$K_{c\ Mid}$	K_c	Total days
	0.35	**0.75**	**1.15**	**0.35**	
Giza102	16 day	21 day	25 day	17	79
Saka 53	16 day	30 day	32 day	16	94

Penman-Monteith equation and Kc, as illustrated in Allen et al.(1998), is presented in the tables (1) and (2) for crop evapotranspiration (ETc), four stages: initial, development, mid, and late. (Saka 53, and Giza 102 varieties). According to Isrealsen and Hansen, (1962)

$$ET_c = ET_o \ X\ Kc \qquad [Eq.1]$$

Where:

ET_c = Crop water consumptive use, mm/day.

ET_0 = Reference evapotranspiration, mm/day.

K_c = crop coefficient.

Emission uniformity (*EU*) is determined as a function of the relation between the average flow by 25% of the emitters with the lowest flow and the mean flow emitted by all the control emitters, as Eq. (1) shows (ASAE 1996a):

$$EU = \underline{q25\%} / q_a \times 100 \qquad [Eq.2]$$

Where:

EU – emission uniformity (%)

q*25%* – average of 25% of the lowest values of flow rate (l/h)

q*a* – average flow rate (l/h)

Crop coefficients, K_c, and mean maximum plant heights for non-stressed, well-managed crops, in subhumid climates (RH_{min} 45%, u_2 2 m/s) are used with the FAO Penman-Monteith ETo. The flow pressure relationship and flow regime of emitters were calculated using Equation 1 (Keller and Karmeli, 1975) (ASAE, 1990).

$$\mathbf{q = k\,H^x} \qquad \textbf{[Eq.3]}$$

“q” is the emitter flowrate, “k” is emitter discharge coefficient, “x” is the emitter discharge exponent, which characterizes the flow rgime and “H” is the entry water pressure (Keller and Karmeli, 1975). Manufacturing variation coefficient (CV m). Has been measured by Equation2 (ASAE, 2002).

$$\mathbf{Cv = S/X} \qquad \textbf{[Eq.4]}$$

“X” is described as the average flow of emitters “S” is as standard deviation. In point source emitters, if Cv mean value is less than 0.05 it is assessed as perfect, between 0.05-0.07 is good, 0.07-0.11 is at limit, 0.11-0.15 is very bad and if it is more than 0.15 that is unacceptable (ASAE, 2002). The "S" value given in Equation 2 is given by Equation 3.

$$\mathbf{S2 = [\ \textstyle\sum (Xi - X\ )^2] / (\ n - 1\ )\ ,} \qquad \textbf{[Eq.5]}$$

Where “Xi” is the emitter flow (1/h) and “n” is the number of emitters. The statistical uniformity between the emitters is determined by Equation 4 (Bralts and Kesner; 1983).

$$\mathbf{Us = 100\ (1- Vq) = 100\ (1-/\ q/\ Sq.)} \qquad \textbf{[Eq.6]}$$

In the equation "Us" defines statistical uniformity (%), "Vq" describes the overall change in emitter flows, "Sq" is the standard deviation of emitter flows and "q" mean emitter flow rate. Statistical uniformity is evaluated as perfect for 95-100%, good for 85-90%, tolerable for 75 - 80%, very bad for 65-70%, unacceptable for 60% and less (ASAE, 1994).

Application uniformity (Eu) expresses the uniformity of emitters.

3) **Sunflower oil:** Expeller gets oil from sunflower seeds after cleaning of impurities and weighing. Oil is collected from all (18) irrigation experiments after filtering and kept it in dark bottles in the refrigerator for analysis.

4) **WUE of seed yield:** WUE is an indicator of the effectiveness of use of irrigation water for crop production. WUE of seed yield was calculated from Equation (6):

$$\text{WUE of seed yield}\left(\frac{\text{kg}}{\text{m}^3}\right) = \frac{\text{Total seed yield (kg/fed.)}}{\text{Total applied irrigation water (m}^3\text{/fed.)}} \textbf{[Eq.6]}$$

5) **WUE of oil yield:** WUE of oil yield is an indicator of effectiveness of irrigation water for crop production, Equation (7):

$$\text{WUE of oil yield (kg/m}^3) = \frac{\text{Total oil yield (kg/fed.)}}{\text{Total applied irrigation water (m}^3\text{/fed.)}} \textbf{[Eq.7]}$$

6) **Proximate composition:** Samples were analyzed for Moisture, Protein, Ash, Fat according to (A.O.AC., 2000). The Carbohydrates were calculated by differences as Nitrogen free extract (NFE).

7) **Oil physico – chemical characteristics:** Acid value, peroxide value and Refractive indexes at 20ºC of oil samples were estimated using procedures - AOAC (2000), Anisidine value was determined by the methods described

by AOCS Official Method Cd 18–90 (AOCS, 1998). Total oxidation value (Totox) was calculated according to the formula described by (Shahidi and Wanasundara, 2002).

Totox value = 2 P.V + An.V **[Eq.8]**

Where: P.V is the peroxide value and An.V is the anisidine value.

RESULTS AND DISCUSSION

1) Irrigation requirements: The effect of water irrigation under two drip irrigation systems with two varieties of sunflower seeds (Saka 53, and Giza 102) on yield related to (2013) and (2014) seasons.

Table (3): Water used in all season, m^3 /fed

Sunflowe Water used m^3 /fed	Control m^3 /fed	100% m^3 /fed	80% m^3 /fed	60% m^3 /fed	50% m^3 /fed
Giza 2013	3800	1662	1330	997	831
Saka 2013	3900	2153	1722	1292	1077
Giza 2014	3800	1618	1294	971	809
Saka 2014	3900	1968	1574	1181	934

2) WUE of seed yield: Water productivity (WP) expresses a physical ratio between yield and water use, Results in fig (2) indicate that in the 1st season (2013), variety Saka53 WUE was greater in (SSDI) than (SDI). Also for variety Giza102 WUE was greater in (SSDI) than (SDI) and the least value was of WUE control treatment Giza102. The highest value of WUE of Giza102 was when applying water at 50% of the ETo of SSDI. In fig (3) the 2nd season (2014) variety Saka53, WUE was greater in (SSDI) than (SDI). Also, variety Giza102, WUE was greater in (SSDI) than (SDI). The least value of WUE was at the control treatment Giza102 .The highest value was WUE of Saka53 when applying water at 60% of the ETo (SSDI).

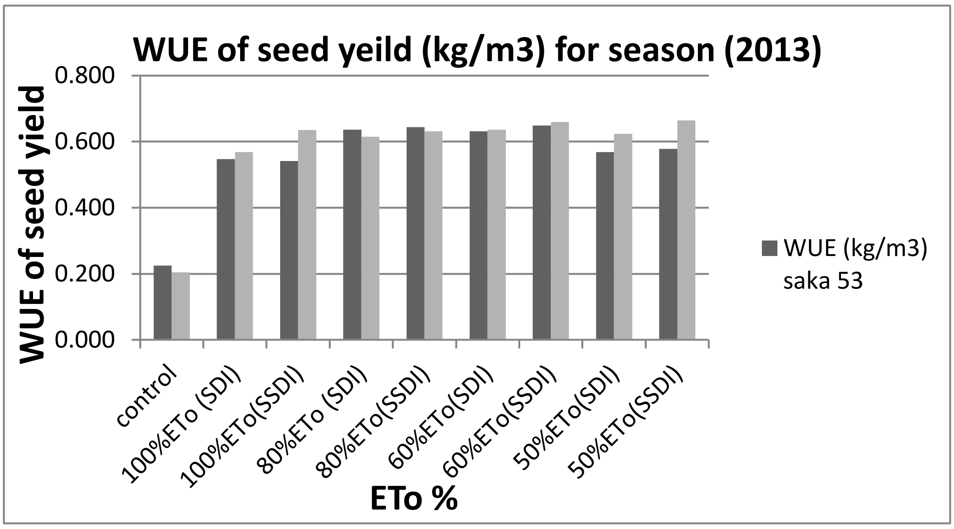

Fig. (2) WUE of seed yield (kg/m3) for sunflower season (2013).

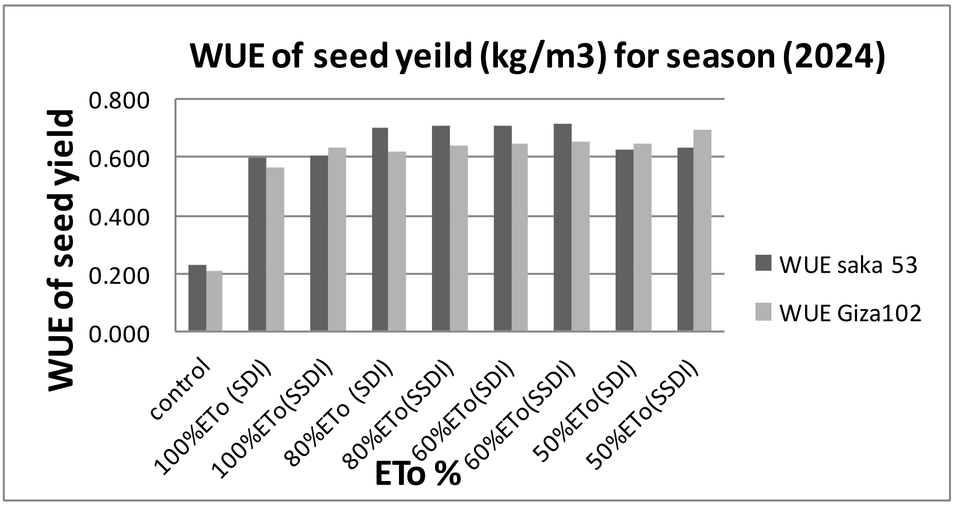

Fig. (3) WUE of seed yield (kg/m3) for sunflower season (2014).

3) WUE of oil yield: Results of fig (5) indicate that, in the 1st season, generally, variety Saka53, WUE of oil was greater in (SSDI) than (SDI). Also, for variety Giza102, WUE was greater in (SSDI) than (SDI) and the least value of WUE for oil was of variety Giza102 control treatment. The highest value WUE of Saka53, was when applying water at 80% of the ETo of (SSDI).

In fig (6) the 2nd season, variety Saka53, WUE was greater in (SSDI) than (SDI). Also, for variety Giza102, WUE was greater in (SSDI) than (SDI). The least value of WUE was for control treatment of Giza102.The highest value of WUE for Saka53 was when applying water at 80% of the ETo (SSDI). In fig .7, the average of two seasons, of WUE seed yield of Saka 53 was when applying water at 80% of the ETo (SSDI) and the least value of WUE for Giza102 was for the control treatment.

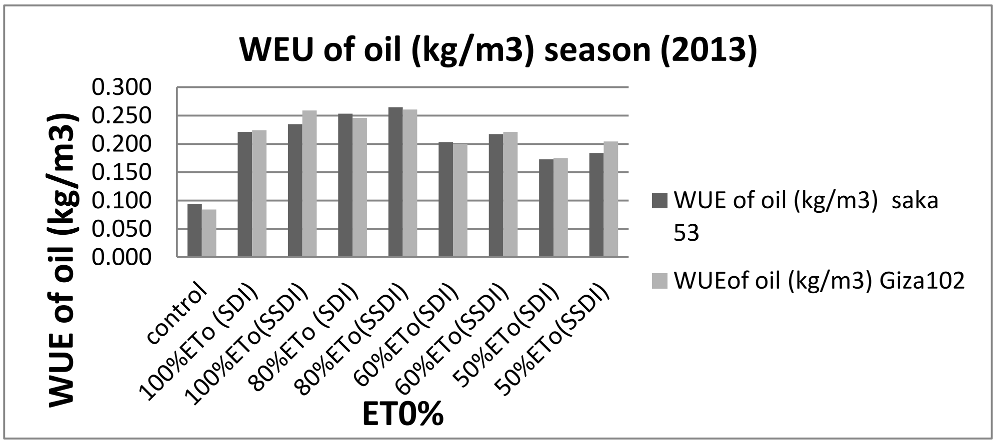

Fig. (4) Water use efficiency of oil seed yield (kg/m3) sunflower season (2013).

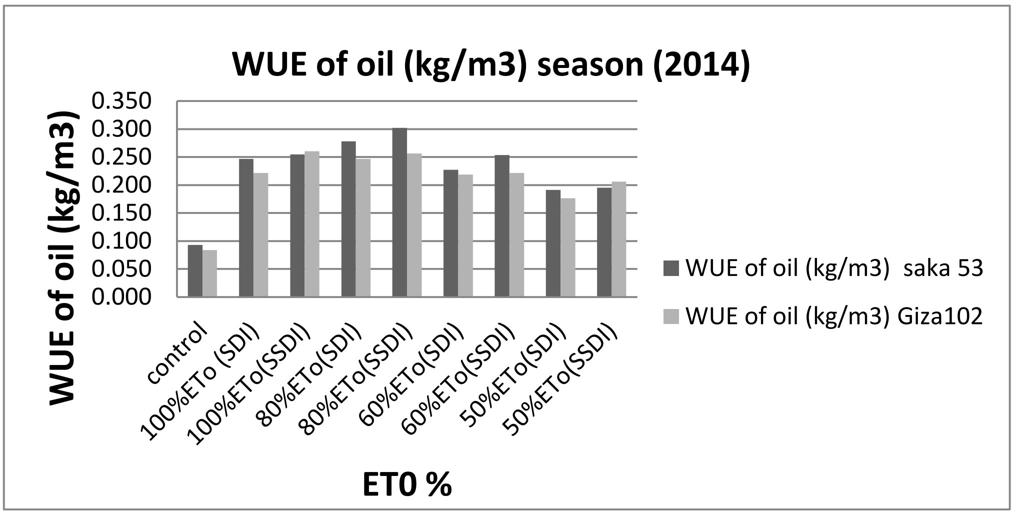

Fig. (5) Water use efficiency of oil seed yield (kg/m3) sunflower season (2014).

4) The crop production: Fig .6: shows curves of the seed yield and total applied water.

1) Water crop relation for season (2013) for Saka 53:

Surface drip irrigation (SDI). $Y = 0.0002x^2 + 1.3381x - 516.96$

Subsurface drip irrigation (SSDI). $Y = 0.0002x^2 + 1.2899x - 454.34$

2) Water crop function season (1) Giza102.

Surface drip irrigation (SDI). $Y = 0.0002x^2 + 0.9965x - 170.72$

Subsurface drip irrigation (SSDI). $Y = 0.0002x^2 + 1.1757x - 277.82$

Integrating the different trials, yield and yield components respond to several parameters, such as stress, water or irrigation applied are determined in Fig .7. Yield relationship with crop water stress (considering averaged Ks-FG parameter), with the percentage of optimal water requirements, and with the percentage of optimal irrigation requirements generated logarithmic curves with R2 equal to 0.9796, 0.9654, 0.9991 and 0.9874 respectively.

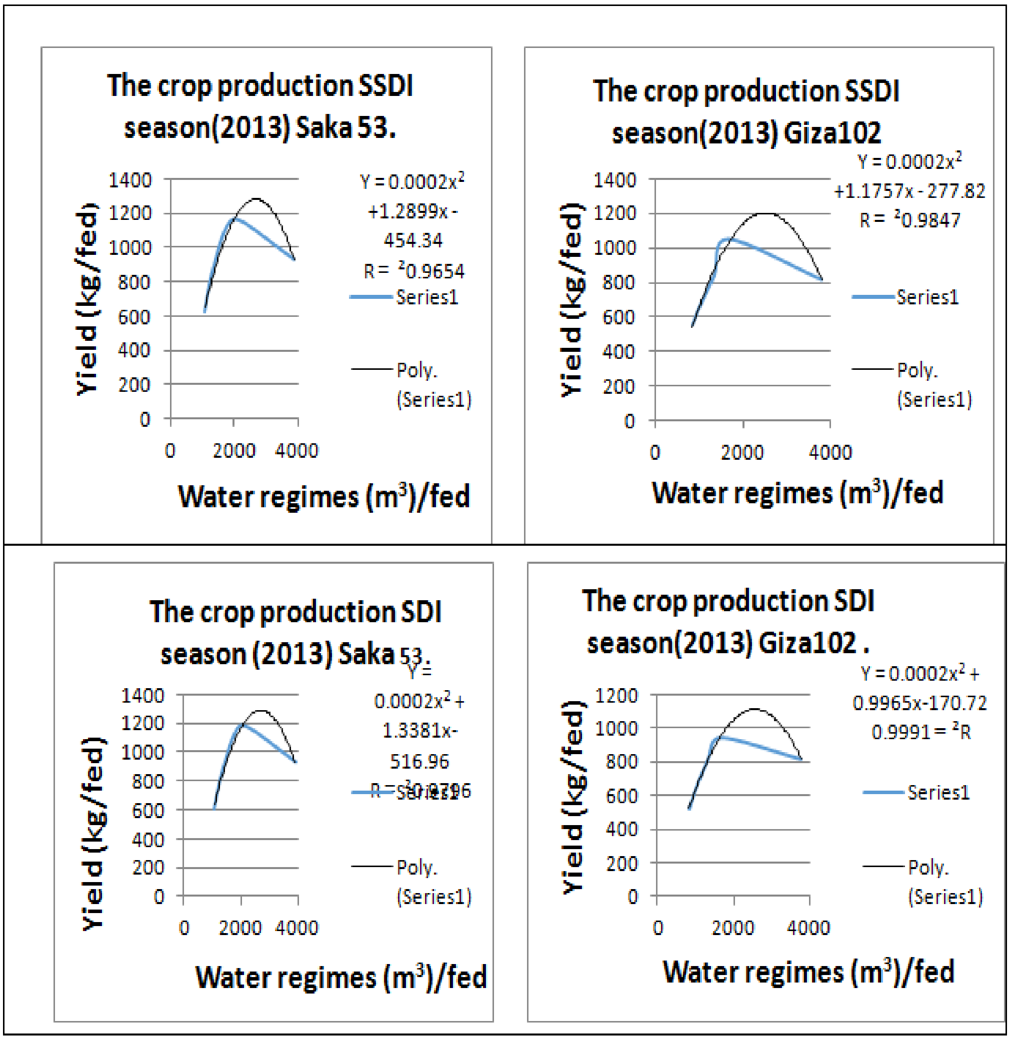

Fig (6) The crop production rate in season (2013).

Fig (7) indicates curves of the seed yield and total applied water.

1) Water crop function for season (2)., Saka 53:

Surface drip irrigation (SDI). $Y = 0.0002x^2 + 1.3318x-477.89$

Subsurface drip irrigation (SSDI). $Y = 0.0003x^2 +1.3486x - 484.34$

2) Water crop function for season (2)., Giza102.

Surface drip irrigation (SDI). $Y = 0.0002x^2 + 0.929x-105.92$

Subsurface drip irrigation (SSDI). $Y = 0.0002x^2 +1.2512x - 357.34$

Integrating the different trials, yield and yield components respond to several parameters, such as stress, water or irrigation is determined in (Fig. 10). Yield relationship with crop water stress, with the % age of optimal water requirements, and with the % age of optimal irrigation requirements generated relations with R2 = 0.9713, 0.9612, 0.9983 and 0.9951 respectively. This result agrees with Lorite *et al.* (2007) and Rinaldi (2001) which coincides with volumes of around 2000 m3 ha−1 to obtain the highest profitability.

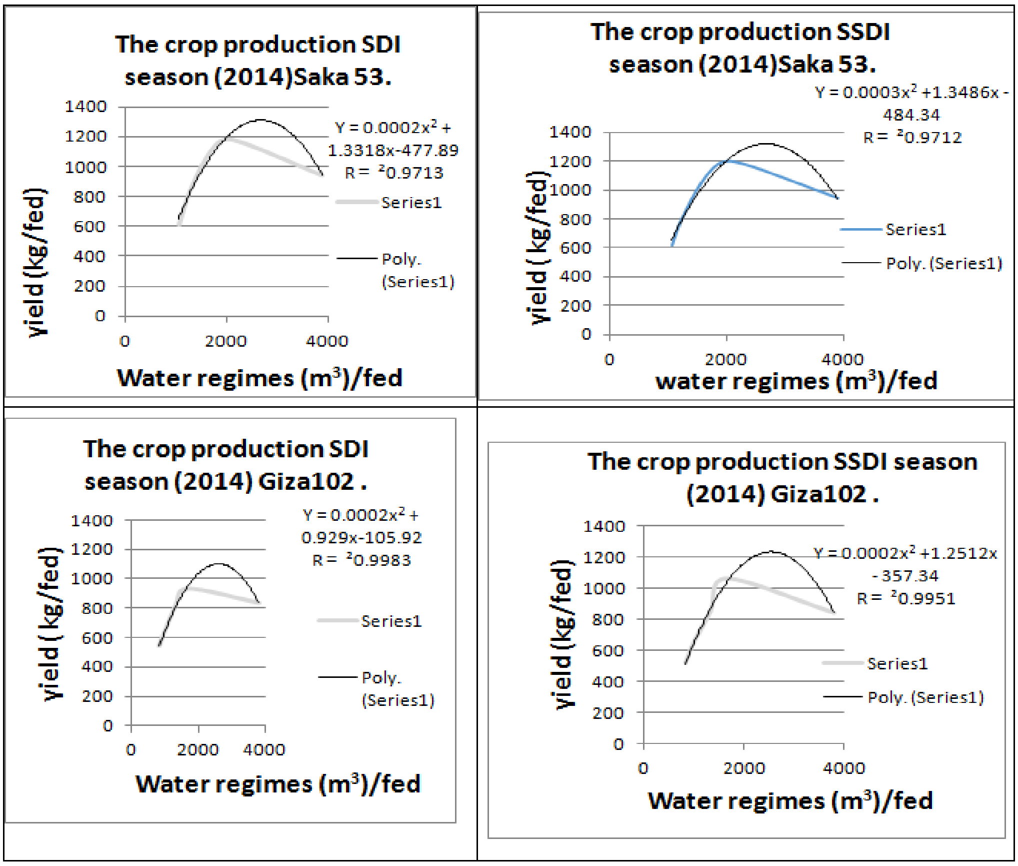

Fig (7) The crop production in season (2014).

5) Effect of the irrigation treatments on seed yield: From table (4), the effect of irrigation treatments on seed yield is in the order of (100%80%60%50%) from K_c. The yield at 100% was always higher than 80%, 60%, and 50%. This means that decreasing irrigation water to 80% of the net water requirement or less reduces the seed yield by more than 50%. Shinde *et al.* (1987) and Cox& Jalliff (1986) found similar results. Significant differences were detected regarding the effect of irrigation method on yield of sunflower seed of two varieties of Sunflower Saka 53 and Giza 102. The difference in productivity between the two varieties is due to genetic traits. Murriel (1975) reported that the highest seed yield was obtained from a treatment having no water stress, whereas the lowest yield was from a non-irrigated application. One of the most important features of subsurface drip irrigation (SSDI) is its potential in saving water comparing with surface drip irrigation system (SDI).

Table (4): The water regimes (m^3) and crop production seed yield in season (2013, 2014).

Irrigation treatments	Water regimes (m^3)		Seed yield (kg/fed)	
	Season (2013)	Season (2014)	Season (2013)	Season (2014)
Saka53 control	3900	3900	933	945
Saka53 100% SDI	2155	2106	1178	1184
Saka53 100%SSDI	2155	2106	1166	1195
Saka53 80%SDI	1724	1685	1096	1108
Saka53 80%SSDI	1724	1685	1108	1120
Saka53 60%SDI	1293	1264	815	836
Saka53 60%SSDI	1293	1264	838	844
Saka53 50%SDI	1078	1053	612	615
Saka53 50%SSDI	1078	1053	623	622
Giza102 control	3800	3800	817	840
Giza102 100% SDI	1662	1670	945	939
Giza102100% SSDI	1662	1670	1055	1061
Giza102 80% SDI	1330	1336	817	826
Giza102 80% SSDI	1330	1336	840	851
Giza102 60% SDI	997	1002	635	646
Giza102 60% SSDI	997	1002	658	652
Giza102 50% SDI	831	835	518	541
Giza102 50%SSDI	831	835	552	583

6) **Effect of the irrigation treatment systems on oil characteristics:** Table (5) shows the interaction between irrigation systems water regimes and two hybrid sunflowers (Giza 102 and Saka 53) on oil characteristics in the first and second seasons. All oil characteristics had significant response to the interaction between the three experimental factors:

7) **Physico-chemical characteristics of sunflower seeds Giza102 and Saka 53:** Oil percentage, an important quality component in sunflower, was processed by irrigation treatments applied at different growth stages. Mean oil percentages varied from 43.40% to 27.2% in the two varieties of Sunflower Saka 53 and Giza 102 in the two seasons. It is clear from Table (5) for seasons (2013) and (2014) that subsurface drip irrigation (SSDI) oil percentage was higher than surface drip irrigation (SDI) with furrow irrigation. On the other hand, sunflower variety Saka 53 was superior then Giza 102 in the two seasons in oil percentage. There are differences in the percentage of oil in the same sunflower variety in the first and second seasons. Seed oil percentage is significantly related to water stress.

A possible factor causing the variable results was water stress during the seed development stage. That agrees with the results of Unger and Thompson, (1982), and explained by Davidescu *et al.,* (1977). Irrigation caused at slightly different growth stages, thus differences in oil percentages in the seed. Also, different irrigation treatments caused water stress in plants, and different transpiration rates and possibly different plant temperatures.

Table (5): Seed sunflower composition (Moisture, Protein, Oil, Ash and NFE* for Giza102 and Saka 53 in season (2013).

Irrigation treatments	Moisture	Protein	Oil	Ash	NFE*
Giza102					
Giza102 control	6.80[a]	10.20[c]	41.00[ab]	4.00[b]	38.00[c]
Giza102 100% SDI	6.60[ab]	11.30[ab]	40.41[b]	4.40[a]	37.28[c]
Giza102 100% SSDI	6.50[ab]	10.80[b]	43.40[a]	4.20[ab]	35.10[c]
Giza102 80% SDI	6.30[abc]	11.70[a]	39.80[b]	4.10[ab]	38.10[c]
Giza102 80% SSDI	6.10[abcd]	11.50[a]	41.10[ab]	4.20[ab]	37.10[c]
Giza102 60% SDI	5.80[bcd]	10.10[c]	32.20[cd]	4.00[b]	47.90[ab]
Giza102 60% SSDI	6.10[abcd]	10.80[b]	33.50[c]	4.10[ab]	45.50[b]
Giza102 50% SDI	5.30[d]	10.50[a]	30.40[d]	4.00[b]	48.80[a]
Giza102 50%SSDI	5.50[cd]	10.00[c]	31.80[cd]	3.30[c]	49.40[a]
Saka 53					
Saka53 control	6.0[ab]	10.40[bc]	41.20[a]	4.10[ab]	38.30[c]
Saka53 100% SDI	6.40[a]	10.50[bc]	41.20[a]	3.40[d]	40.30[c]
Saka53 100%SSDI	6.20[a]	9.70[d]	40.80[a]	3.50[cd]	39.80c
Saka53 80%SDI	5.30[bc]	10.80[b]	40.10[a]	3.80[bc]	40.00[c]
Saka53 80%SSDI	5.20[c]	11.60[a]	41.30[a]	4.00[ab]	37.90[c]
Saka53 60%SDI	5.10[c]	10.00[cd]	31.40[bc]	4.10[ab]	49.40[b]
Saka53 60%SSDI	5.10[c]	9.90[cd]	33.60[b]	4.00[ab]	47.40[b]
Saka53 50%SDI	5.00[c]	9.90[cd]	28.10[d]	4.20[a]	52.80[a]
Saka53 50%SSDI	5.10[c]	9.90[bc]	30.80[c]	3.80[bc]	49.90[b]

Means with the same letter in the column had non- significant differences ($P>0.05$) - Surface drib irrigation (SDI). Subsurface drip irrigation (SSDI).
*= calculated by difference = Nitrogen free extract.

Table (6): Sunflower seed composition (Moisture, Protein, Oil, Ash and NFE*for Giza102 and Saka53 in season (2014).

Giza102					
Irrigation treatments	Moisture	Protein	Oil	Ash	NFE*
Giza102 control	6.70a	9.60e	39.90a	3.00b	40.80c
Giza102 100% SDI	6.70a	11.60b	39.40a	4.00a	38.30bc
Giza102 100% SSDI	6.70a	11.80b	41.00a	4.00a	36.50d
Giza102 80% SDI	6.00b	11.80b	39.90a	4.00a	38.30cd
Giza102 80% SSDI	5.80bc	12.70a	40.20a	4.00a	37.30d
Giza102 60% SDI	6.00b	10.40d	33.90b	4.00a	45.70b
Giza102 60% SSDI	6.00b	11.80b	34.00b	4.00a	44.20b
Giza102 50% SDI	5.53d	10.90c	27.20d	4.00a	52.36a
Giza102 50%SSDI	5.40d	10.06d	29.50c	3.00b	52.03a
Saka53					
Saka53 control	6.06b	10.30c	40.80ab	3.83a	43.39c
Saka53 100% SDI	6.70a	10.10cd	41.00ab	3.00b	44.28c
Saka53 100%SSDI	6.60a	9.84d	42.10a	3.00b	43.36c
Saka53 80%SDI	5.00c	11.20b	39.50b	4.00a	43.28c
Saka53 80%SSDI	5.00c	11.80a	42.50a	4.00a	40.47d
Saka53 60%SDI	5.00c	12.00a	32.10c	4.00a	50.55b
Saka53 60%SSDI	5.00c	10.30c	32.50c	3.00b	52.73b
Saka53 50%SDI	5.00c	10.94b	30.60c	3.00b	55.46a
Saka53 50%SSDI	5.00c	10.06cd	30.90c	3.00b	56.03a

Means with the same latter in the column had non- significant differences (P>0.05) - Surface drib irrigation (SDI). Subsurface drip irrigation (SSDI). *= calculated by difference = Nitrogen free extract.

8) Physico-chemical characteristics of sunflower oils of Giza102 and Saka 53.: Physico-chemical characteristics of different oil samples were extradited from sunflower crop treated under different irrigation methods during seasons 2013 and 2014 and presented in table (6,7).

In season (2013), Giza 102 had the highest Acid value (AV) mg KOH compared with the control sample .The lowest AV mgKOH was observed 0.94 by using 100% SSDI of ET_0. Saka 53 had the highest AV mgKOH as observed 1.71 obtained by using control. The lowest AV mg KOH was observed 0.98 by using 100% SSDI of ETo. At season (2014) Giza 102 had the highest AV which was 1.25 obtained by using 50% SDI of ETo. The lowest AV KOH/g was observed 1.02 by using 100% SSDI of ET0. Saka 53. The highest AV KOH/g was observed as 1.18 obtained by using 60% SSDI of ETo. The lowest AV KOH/g was observed 0.89 by using 80% SSDI of ETo. Abitogun and Oshodi (2010) found that acid value content was 2.78 mg KOH/g oil sunflowers. Lamas *et al.* (2016) noted that the acidity of crude oil sunflower is accepted among 2.290 ± 0.050 (mg KOH/g oil).

At season (2013), Giza 102 had the highest Peroxide value PV meq.O_2/kg oil as 3.88 obtained by using 50%SSDI of ETo. The lowest PV meq.O_2/kg oil was 3.17 by using 80% SSDI of ETo. Saka 53 had the highest PV meq.O_2/kg oil that was 3.99 obtained by using 60% SSDI of ETo. The lowest PV meq.O_2/kg oil was 3.26 by using 60% SDI of ETo. At season (2014) Giza 102 had the highest PV meq.O_2/kg oil as 4.54 obtained by using 50% SSDI of ETo. The lowest PV meq.O_2/kg oil was 2.86 by using 80% SSDI of ET0. Saka 53 had the highest PV meq.O_2/kg oil at 4.55 obtained by using 50% SDI of ETo. The lowest PV meq.O_2/kg oil was for oil 2.71 by using 80% SDI of ET0. For proper handling, Gupta (2003) suggested to maintain a peroxide value of less than 4 in the crude oil during storage. Lamas *et,al* (2016) The Peroxide value, PV (meq.O_2/kg) for crude oil sunflower is 3.660 ± 0.160 . At season (2013), Giza 102 had the highest Anisidine value. AnV meq./kg oil was 2.07obtained by using control. The lowest AnV meq./kg oil was 1.21by using 100% SSDI of ET0. Saka 53 had the highest AnV meq./kg oil which was 2.89 obtained by using 100%SSDI of ETo. The lowest AnV meq./kg oil was 1.63by using 60%SDI of ET0. At season (2014), Giza 102 had the highest AnV meq./kg oil, which was 2.03obtained by using 80%SDI of ETo . The lowest AnV meq./kg oil was 1.14 by using 60% SDI of ET0. Saka 53 had the highest AnV meq./kg oil which was 2.42 obtained by using 100% SSDI of ETo. The lowest AnV meq./kg oil was 1.24by using 60%SDI of ETo. RI and IV values were indicative of unsaturation levels and as a result oil' tendency to undergo autoxidation (Farhoosh *et al*., 2008). Decreased levels of unsaturation (linoleic acid) will result in increased levels of oxidative stability. The PV and p-An V gave an indication of the initial oxidative status of the extracted oil samples. The use of PV and AN.V together provides a comprehensive overview of the oxidation process in oils. This is a mathematical prediction of oxidative stability and the value is calculated as TOTOX value was used as an indication of overall oxidative stability and was correlated with the extent of oil deterioration (Zhang *et al*.) 2010 and (De Abreu *et al*.) 2010. At season (2013), Giza 102 gave the highest TOTOX which was 9.26 obtained by using 50%SSDI of ETo. The lowest TOTOX was 7.72 by using 80% SSDI of ETo. Saka 53 gave the highest TOTOX which was 10.84 obtained by using 80%SSDI of ETo. The lowest TOTOX was 8.13 by using 60%SDI of ETo. At (2014) season, Giza 102 gave the highest TOTOX which was 10.55 obtained by using 50%SSDI of ETo. The lowest TOTOX which was 7.74 by using 80% SSDI of ETo. Saka 53 gave the highest TOTOX which was 11.26 obtained by using 50% SDI of ET0. The lowest TOTOX was 6.61by using 60% SDI of ETo. Refractive indexes at 20ºC. at season (2013) for Giza 102 and Saka 53, at all treatments were not different.

Table (7): Physico-chemical characteristics of sunflower oil extracted from seed Giza102 and Saka 53 for irrigation requirements in season (2013).

Irrigation treatments	AV mg KOH/g oil	PV meq.O_2 /kg oil	AnV meq./kg	TOTOX	RI*
Giza102					
Giza102 control	1.19[a]	3.28[b]	2.07[a]	8.63[cb]	1.4849
Giza102 100% SDI	1.02[cd]	3.22[b]	1.66[cb]	8.10[cbd]	1.4842
Giza102 100% SSDI	0.94[d]	3.31[b]	1.21[d]	7.85[cd]	1.4847
Giza102 80% SDI	1.08[cd]	3.35[b]	1.49[cb]	8.20[cbd]	1.4748
Giza102 80% SSDI	0.97[d]	3.17[b]	1.36[cd]	7.72[d]	1.4751
Giza102 60% SDI	1.11[b]	3.50[b]	2.00[ab]	9.00[a]	1.4747
Giza102 60% SSDI	1.02[cbd]	3.49[b]	1.70[cb]	8.68[ab]	1.4745
Giza102 50% SDI	1.19[A]	3.50[b]	1.58[cb]	8.58[acb]	1.4743
Giza102 50%SSDI	1.06[cb]	3.88[a]	1.49[cd]	9.26[a]	1.4841
Saka 53					
Saka53 control	1.71[a]	0.98[cb]	2.06[cb]	8.84[cd]	1.4841
Saka53 100% SDI	1.31[b]	3.46[cb]	2.34[cb]	9.26[cbd]	1.4842
Saka53 100%SSDI	0.91[de]	3.44[cb]	2.89[ab]	9.77[acb]	1.4845
Saka53 80%SDI	1.16[cb]	3.50[cb]	1.63[c]	8.64[cd]	1.4839
Saka53 80%SSDI	0.85[e]	3.63[b]	3.56[a]	10.84[a]	1.4835
Saka53 60%SDI	1.16[cb]	3.26[c]	1.61[c]	8.13[d]	1.4840
Saka53 60%SSDI	1.03[cd]	3.99[a]	2.27[cb]	10.25[ab]	1.4845
Saka53 50%SDI	1.06[cd]	3.65[b]	2.13[cb]	9.44[bc]	1.4841
Saka53 50%SSDI	0.98[de]	3.69[b]	1.92[c]	9.31[bcd]	1.4846

Means with the same latter in the column had non- significant differences (P>0.05).
*Refractive index at 20ºc (RI), Surface drip irrigation (SDI). Subsurface drip irrigation (SSDI).

Table (8): Physico-chemical characteristics of sunflower oil extracted from seed Giza102 and Saka 53 for irrigation requirements in season (2014).

Irrigation treatments	AV mg KOH/g oil	PV meq.O_2/ kg oil	AnV meq./ kg	TOTOX	RI*
Giza102					
Giza102 control	1.22[a]	3.29[bc]	1.67[ab]	8.26[cd]	1.4750
Giza102 100% SDI	1.18[ab]	4.23[a]	1.41[ab]	9.88[ab]	1.4756
Giza102 100% SSDI	1.02[bc]	3.54[b]	1.53[ab]	8.61[bcd]	1.4753
Giza102 80% SDI	1.17[abc]	3.35[bc]	2.03[a]	8.73[bcd]	1.4752
Giza102 80% SSDI	1.17[c]	2.86[c]	2.01[a]	7.74[d]	1.4753
Giza102 60% SDI	1.23[a]	4.14[a]	1.14[b]	9.43[abc]	1.4752
Giza102 60% SSDI	1.15[abc]	4.33[a]	1.24[b]	9.90[ab]	1.4752
Giza102 50% SDI	1.25[a]	4.44[a]	1.44[ab]	10.34[a]	1.4751
Giza102 50%SSDI	1.09[abc]	4.54[a]	1.47[ab]	10.55[a]	1.4750
Saka 53					
Saka53 control	1.84[a]	3.45[b]	1.56[bc]	8.46[cd]	1.4755
Saka53 100% SDI	1.35[b]	3.57[b]	2.14[ab]	9.28[bc]	1.4753
Saka53 100%SSDI	0.95[d]	4.29[a]	2.42[a]	11.01[a]	1.4757
Saka53 80%SDI	1.17[bc]	2.71[c]	2.08[ab]	7.50[de]	1.4743
Saka53 80%SSDI	0.89[d]	4.35[a]	1.84[ab]	7.50[a]	1.4742
Saka53 60%SDI	1.26[b]	2.68[c]	1.24[c]	6.61[e]	1.4742
Saka53 60%SSDI	1.18[bc]	4.52[a]	1.93[ab]	10.98[a]	1.4749
Saka53 50%SDI	0.99[cd]	4.55[a]	2.16[ab]	11.26[a]	1.4748
Saka53 50%SSDI	0.97[cd]	4.24[a]	1.79[bc]	10.28[ab]	1.4751

Means with the same latter in the column had non- significant differences (P>0.05)
*Refractive index at 20ºc (RI), Surface drip irrigation (SDI). Subsurface drip irrigation (SSDI).

8 -1 Fatty acid profile: Fatty acid profiles for different sunflower oil samples were extracted from seeds Saka 53 irrigated under different conditions presented in Table (8). The total saturated fatty acids mono unsaturated fatty acids and polyunsaturated fatty acids ranged between 10.4 to 11.9 %, 17.6 to 31.5 % and 58.3 to 71.4 % respectively. Total saturated fatty acids percentage, not affected by irrigation treatments, ranged between 50 to 100 % SDI or SSDI compared to the control samples. Also, the oil samples were extracted from sunflower seeds treated at 80 % SDI, 80 % SSDI and 60 % SDI had 31.5, 28.0 and 31.3 % for mono unsaturated fatty acids, respectively compared to the control sample that had 30.8 %.The polyunsaturated fatty acids percentages were 58.3, 61.2 and 31.3 %, respectively. In contrast, the mono unsaturated fatty acids percent was dramatically decreased to level ranging between 17.6 to 18.6 % for the other irrigation methods. Therefore, the polyunsaturated fatty acids increased to levels ranging between 69.9 to 72.0 % compared to the control sample which had 58.5 %. Generally, the decreases in the mono unsaturated fatty acid levels lead to increases in the polyunsaturated fatty acids. This relation result shows the effect of some irrigation methods in the oleic and linoleic acids biosynthesis. According to the obtained data, the oleic acid decreased with increased linoleic acid in the oil samples which were extracted from the seeds. Those were affected by the irrigation method as previously clarified. The total saturated fatty acids was not affected by different irrigation methods. The fatty acid profiles for the different oil samples were extracted from seeds Giza 102. Those were treated by the same irrigation methods presented in Table (9). Generally, no effect was observed between the treated samples and the control sample. The total saturated fatty acids mono unsaturated fatty acids ranged between 10.2 to 11.5 % compared to the control sample which was 10.9 %. Monounsaturated fatty acids ranged between 20.3 to 17.6 % compared to the control sample which had was 19.5%. At the same time, polyunsaturated fatty acids in control sample was 69.6 % in the range with the other treated samples that ranged between 68.6 to 71.9 %.

Table (9): Fatty acid profile sunflower oil Saka 53**.**

Fatty acid	Ska53 contro-l	Saka53 100% SDI	Saka53 100%SSDI	Saka53 80%SDI	Saka53 80%SSDI	Saka53 60%SDI	Saka53 60%SSDI	Saka53 50%SDI	Saka53 50%SSDI
C16:0	6.0	5.8	6.9	6.1	6.1	6.1	6.0	6.6	6.6
C16:1	0.1	0.1	0.3	0.2	0.1	0.1	0.5	0.1	0.1
C17:0	0.0	0.1	0.2	0.1	0.0	0.0	0.2	0.1	0.1
C17:1	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0
C18:0	3.6	3.4	3.8	3.7	3.7	3.7	2.7	3.7	3.8
C18:1	30.6	17.2	17.6	31.1	27.8	31.0	17.9	17.4	17.5
C18:2	58.4	71.2	69.8	58.2	61.1	57.8	71.9	70.9	70.8
C18:3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
C20:0	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.3
C20:1	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.1	0.2
C22:0	0.8	0.8	0.8	0.0	0.7	0.7	0.3	0.6	0.7
TSFA	10.7	10.4	11.9	10.1	10.7	10.7	9.4	11.3	11.4
MUFA	30.8	17.6	18.2	31.5	28.0	31.3	18.6	17.7	17.8
PUFA	58.5	71.4	69.9	58.3	61.2	57.9	72.0	71.0	70.9

Table (10): Fatty acids profile sunflower oil Giza102.

Fatty acid	Giza102 contro-l	Giza102100 % SDI	Giza102 100%SSDI	Giza102 80%SDI	Giza102 80%SSDI	Giza102 60%SDI	Giza102 60%SSDI	Giza102 50%SDI	Giza102 50%SSDI
C16:0	6.3	6.5	6.7	5.8	6.2	6.3	6.6	6.3	6.3
C16:1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1
C17:0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
C17:1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C18:0	3.7	3.6	3.7	3.8	3.7	3.6	3.6	3.7	3.7
C18:1	19.2	17.3	17.5	17.6	18.9	20.0	17.3	17.5	17.4
C18:2	69.5	71.1	70.6	71.8	70.0	68.5	71.0	70.9	71.1
C18:3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
C20:0	0.2	0.3	0.3	0.3	0.3	0.2	0.3	0.4	0.3
C20:1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
C22:0	0.7	0.8	0.7	0.4	0.5	0.9	0.8	0.8	0.8
TSFA	10.9	11.1	11.5	10.2	10.7	11.1	11.3	11.2	11.1
MUFA	19.5	17.7	17.8	17.8	19.2	20.3	17.6	17.8	17.7
PUFA	69.6	71.2	70.7	71.9	70.1	68.6	71.1	71.0	71.2

CONCLUSION

Subsurface drip irrigation is more compatible for irrigating sunflower than surface drip irrigation, as it gave the highest growth parameters , seed yield (kg/fed) and oil% in seed for all experiments. WUE of seed yield was greater in (SSDI) than (SDI). Also, WUE of oil yield was greater in (SSDI) than (SDI). The treatment of Saka53 when applying water at 80% of the ETo (SSDI) had 41.3% oil yield .At the same time, the oil quality was improved by increasing the Poly unsaturated fatty acids from 58.54 in the content sample to 61.2% in the treated seed. On the other hand variety Giza102 at 100% of the ETo (SSDI) had significantly ($p<0.05$). The highest oil yield was 43.4% with 70.79 polyunsaturated fatty acid. AU the physico-chemical characteristics of the extracted oil were not affected by the different irrigation treatments. The Acid Value (AV) mg KOH/g oil, Peroxide value (PV) meq.O_2/kg oil, Anisidine value AnV meq./kg oil, TOTOX and refractive indexes at 25ºC were lower than these in the standards . Significant differences between the means do not express the good or poor quality of the oil. However, all the produced oil had chemical good quality. That means, no effect of the irrigation methods on the chemical sunflower oil quality extracted from two hybrid seeds.

According to the obtained result, there are two environmental benefits:

1- Saving the irrigation water during cultivation of sunflower crop.

2 – The fatty acid profile of the sunflower oil is improved with more polyunsaturated fatty acid. The consumer will have healthy benefit with that oil.

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تأثير الري بالتنقيط على انتاج زيت دوار الشمس في الاراضي الرملية

[٤]

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المستخلص

يتناول البحث تأثيرات معاملات الري علي خواص زيت دوار الشمس المستخلص. ونتج التالي: لموسم ٢٠١٤,٢٠١٣ لنظامي ري بالتنقيط السطحي وتحت السطحي. وشملت المعاملات صنفي دوار الشمس سخا ٥٣ وجيزة ١٠٢ . وأظهرت النتائج لعام ٢٠١٣ وجيزة ١٠٢، لنظامي الري بالتنقيط السطحي وتحت السطحي التالي : تراوح النتح بخر من٥٠ الى١٠٠ % والناتج المحصولي من ٥١٨ الى ١٠٥٥ كج/ فدان ونسبة الزيت من ٣٠,٤الى ٤٣,٤% . وهناك نتائج مقابلة للموسم التالي للناتج المحصولي ونسب استخلاص الزيت لنظامي الري وصنفي دوار الشمس المختبريين.

وفى الخلاصة، فان معاملات الري لها تأثيرات كبيرة على انتاج الزيت ونوعيته.