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EFFECT OF SOWING DATES AND IRRIGATION REQUIREMENTS ON SEED YIELD AND OIL COMPOSITION OF TWO SUNFLOWER CULTIVARS IN NORTH SINAI REGION

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ABSTRACT

The aims of this study were to determine the suitable sunflower cultivar (Giza-102 and Sakha-53) under North Sinai conditions that gave optimum seed yield and fatty acid composition in relation to planting dates (30th April, 30th May and 30th June) and irrigation requirements (50%, 75%, 100% IR). Experiment was carried out during 2018 and 2019 seasons, at the farm of the Fac. Environ. Agric. Sci., Arish Univ., North Sinai, Egypt. Results refers that oil yield was increased as sowing date early beyond the 30th of April. Also, the healthier oils with high unsaturated fatty acids (UFA) and low total saturated fatty acids (TSFA) recorded with 30th April planting date. But delayed to June 30th planting date treatment achieved the highest averages of TSFA (%). Full irrigation requirement treatment was achieving higher economical seed and oil yields. Meanwhile, reduce water to 50% IR treatment is suitable for development sunflower oils with high USFA (%) and low TSFA (%). Sakha 53 sunflower cultivar produced significantly higher plant seed and oil yields than Giza 102. Generally, data revealed that planting sunflower cv. Sakha 53 on end-April using 100% IR followed by 75% IR irrigation treatments gave the highest seed yield and oil components. On the contrary, sown Giza 102 or Sakha 53 plants on June 30 and irrigated with 50% IR gave the lowest values in 1st and 2nd seasons.

INTRODUCTION

Sunflower is produced one of the most common oilseed types in Egypt which are in high demand from consumers **(El-Hamidi and Zaher, 2018)**. It is reach with unsaturated fatty acid as, oleic acid and seeds content about 42.5% oil **(El-Awady *et al.*, 2017)**.

Egypt needs to increase agricultural production of the sunflower crop to face self-sufficiency proportion which recorded 95% at 2020 (**FAO, 2020)**. But some problems have been faced Egypt to increase agricultural production of the sunflower such as increasing air temperature and limited water sources **(Kosar *et al.*, 2021; Mourad and El-Mehy, 2021; Giannini *et al.*, 2022; Morsy *et al.*, 2022)**.

A significant increase in head diameter, seed yield, oil yield and oil composition when delaying sowing date of sunflower. **(Hamza and Safina, 2015; Ahmed *et al.*, 2020; Mourad and El-Mehy, 2021)**. Thus, the time of planting is more important factors in achieving high yield, which can differ significantly between sowing sunflower in early (spring) or late sowing date (summer) (**Qadir *et al.*, 2007**).

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The average water requirements (IR) of sunflower are about 900 mm, thus decreasing irrigation water to less than 75% of IR cause decrease in seed yield at 50% **(Allam and Gamal, 2007; El-Awady *et al*., 2017; Negm, 2019; FAO, 2020; Kosar *et al*., 2021)**.

Performance of sunflower cultivars are differently affected by heat stress under different sowing dates and drought stress. Sakha 53 recorded higher oil yield than Giza 102 by 43.40% and 27.2%, protein percentage has been decreased with Giza 102 compared to Sakha 53 **(El-Aref *et al*., 2011; Hamza and Safina, 2015; El-Awady *et al*., 2017).** This may be due to differences in genetic makeup of Sakha 53 and adaptive to climatic and soil conditions more than Giza-102 **(El-Aref *et al*., 2011)**.

Thus, this study was conducted to determine the suitable sunflower cultivar (Giza-102 and Sakha-53) under North Sinai conditions that gave optimum seed yield and fatty acid composition in relation to planting dates (30^{th} April, 30^{th} May and 30^{th} June) and irrigation requirements (50%, 75%, 100% IR).

MATERIALS AND METHODS

Experiment was carried out during 2018 and 2019 seasons, at the experimental farm of the Fac. of Environ. Agric. Sci., Arish Univ., Egypt. Table 1 presented the climatic data of El-Arish City, **(CLAC, Egypt 2019)**. The soil physical properties of the experimental plots were determined according to **Klute (1986)** and the shown in Table 2.

Sunflower-seeds were obtained from Agri. Research Center, Egypt. Seeding rate was 4 kg fed^{-1}. Seeds were sown by dibbling method putting 2–3 seeds/hill in 5 row subplots, 8 m long with 0.50m space between rows and 0.25m between plants on the same line to gain plot area of 20 m^2. The plants were thinned to 1 plant after two weeks from sown. Drip irrigation system was using. A split-spilt plot layout design was used, the main plots were arranged for planting dates (April 30^{th}, May 30^{th} and June 30^{th}), subplots were occupied by irrigation levels (50%, 75% and 100% IR and sub-sub plots were planted with two sunflower cultivars: Sakha-53 and Giza-102. Table 3 shows the seasonal irrigation quantities (m^3/feddan/season) for sunflower under different irrigation treatments during the two seasons.

Calculations of irrigation levels were done whereas the irrigation control was practiced *via* manual valves for each experimental plot. The total amount of irrigation water was calculated by Food and Agricultural Organization (FAO) Penman-Monteith (PM) procedure, FAO 56 method **(Allen *et al*., 1998).** The potential evapotranspiration (ETo) as follows:

$$ET_o = \frac{0.408\Delta\,(R_n - G) \, + \, \gamma \frac{900}{T + 273} u_2(e_s - e_a)}{\Delta + \gamma(1 + 0.34\, u_2)}$$

Where:

ETo = Daily reference evapotranspiration [mm d1].

Rn =Net radiation at the crop surface (MJ m^2 day^{-1}),

G = Soil heat flux density (MJ m^2 day^{-1}),

T=Mean daily air temperature at 2 m height (°C),

U_2 = Wind speed at 2 m height (m $sec.^{-1}$),

es = Saturation vapor pressure (kPa),

ea = Actual vapor pressure (kPa),

Δ=The slope of vapor pressure curve (kPa $°C^{-1}$),

γ = The psychometric constant (kPa °C-1).

Irrigation requirement (IR) was calculated as follows:

IR=(ETo*Kc)*(LR)*4.2/Ea.. (m^3/feddan/ day)

Where: IR = Irrigation requirement for sunflower - m^3 / feddan/ day.

Table 1. Climatic data of El-Arish city during of 2018 and 2019 seasons

Month	Temperature °C			Humidity (%)	Windspeed km/ day	Sol. Radiat. MJ/m^2/ day	Rainfall (mms)	Eto mm/day
	Max	Min	Mean					
				First season (2018)				
April	27.3	13.3	20.3	57.0	218	20.4	6.1	5.0
May	30.9	16.1	23.5	57.8	209	24.5	3.2	6.2
June	33.2	18.9	26.05	61.2	205	27.9	0.0	7.3
July	35.2	21.3	28.2	62.9	195	26.9	0.0	7.3
Aug.	35.8	21.9	28.8	63.8	182	24.5	0.2	7.2
Sept.	34.4	20.4	27.4	60.4	187	20.1	0.6	6.9
Oct.	32.8	18.0	25.4	62.1	160	15.9	6.0	5.6
				Second season (2019)				
April	26.2	13.7	19.9	56.5	209	20.8	8.1	5.1
May	29.7	16.6	23.1	60.2	201	25.0	0.0	6.3
June	31.9	19.5	25.7	60.7	197	28.5	0.0	7.4
July	33.8	21.9	27.9	65.5	187	26.4	0.0	7.3
Aug.	34.3	22.6	28.4	66.4	175	25.0	0.0	7.2
Sept.	33.0	21.0	27.0	59.8	180	19.7	1.2	6.7
Oct.	31.5	18.5	25.0	61.5	154	16.2	8.2	5.4

Table 2. Physical soil properties of the experimental site

Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Organic Carbon (%)	Drained level		Saturation	Bulk density g/cm^3	Root growth factor 0 to 1
					Lower limit	Upper limit			
0-5	2.9	12.3	84.8	0.58	0.11	0.25	0.33	1.2	0.8
5-15	2.9	12.3	84.8	0.80	0.11	0.25	0.33	1.2	1.0
15-30	2.8	12.4	84.8	0.90	0.11	0.25	0.33	1.2	0.5

Table 3. Irrigation quantities of sunflower under different irrigation levels in the three planting dates at Arish area- North Sinai at 2018 and 2019 season

Total	1st sowing date			2nd sowing date			3rd sowing date		
	100%	75%	50%	100%	75%	50%	100%	75%	50%
					m^3 / feddan/season				
2018 season	3231	2423	1615	3120	2340	1560	2828	2121	1414
2019 season	3185	2389	1592	3093	2320	1546	2813	2110	1407

ETo = Average weekly evapotranspiration mm/day.

Kc = Crop evapotranspiration according to **Allen *et al*. (1998).**

LR = Leaching requirement which assumed 10% in this study.

Ea= Efficiency of irrigation system which measured during season average was 90%.

At harvest, randomly eight plants from each plot were taken to record seeds yield that computed by multiplying seed wt./ m^2 by 4200 m^2.

The oil content percentage (d.m) determined by a Soxhlet methods according to **Lowary *et al.* (1951)**. Oil yield was calculated from following equation:

Oil yield=seed yield fed^{-1} × seed oil percentage

The protein content was calculated by multiplying the N by the converting factor 6.25 according to **Hymowitz *et al.* (1972)**. Fatty acids content (FAs) was separated and identified by Gas Liquids Chromatography according to **Farag *et al.* (1981)**.

Statistically analyzed data was carried out using Co-STAT software, V.6.13. Duncan's multiple ranges test was used to compare means at P≤5% **(Duncan, 1955)**.

RESULTS AND DISCUSSION

Seed Yield (kg/fed.)

Reductions obtained in seed yield than the excelsior treatment of early sowing (end-April) by the latest sowing dates were amounted to 30.62 and 49.77% in end-May and end-June, respectively in 1st season. Analogous reduction values in the 2nd season were observed and valued 28.39 and 50.47% in end-May and end-June, respectively. The proper climatic conditions accompanied the first sowing date led to increases in all the investigated vegetative growth traits. This increase resulted to estimated increase in all the determined yield components which surely reflected in the observed increase of seed yield. The obtained results were in line with that obtained by **Flagella *et al.* (2002); Baghdadi *et al.* (2014); Sheoran *et al.* (2014); Hamza and Safina (2015); Ozturk *et al.* (2017); Mourad and El-Mehy (2021); Saudy *et al.* (2021).**

Concerning the effect of IR on seed yield the results showed that there were a gradually reduce in relation with decrease the amount of irrigation water. The average greatest seed yield (1348.01 and 1318.97 kg/fed., in the first and second seasons, respectively) were obtained from the full irrigation requirement treatment (100% IR), whereas the lowest seed yield (688.44 and 717.46 kg/fed., in the 1st and 2nd seasons, respectively) was obtained from the 50% IR treatment. These results agree with those obtained by **Go¨ksoy *et al.* (2004); Kazemeini *et al.* (2009); Hossain (2010); Alahdadi *et al.* (2011), Yawson *et al.* (2011); Shahri *et al.* (2012)**; **Saeed *et al.* (2015)**; **El-Awady *et al.* (2017)**; **Patanè *et al.* (2017); Ebrahimiana *et al.* (2019); Keipp *et al.* (2020).**

Regarding sunflower cultivars, Sakha 53 was produced the highest seed yield (1169.41 and 1168.52 kg/fed. in 1st and 2nd seasons, respectively). Conversely, Giza 102 gave the lowest value of seed yield (984.82 and 993.79 kg/fed. in 1st and 2nd seasons, respectively). Seeds yield (kg/fed) of Sakha 53 was significantly higher than those obtained by Giza 102 sunflower cultivar in the first season by 15.78% and 14.95% in the second season. Differences in seed yield between the studied sunflower cultivars may be attributed largely to the genetical make up of these cultivars. These results agree with those obtained by **El-Sarag (2007); Abdel-Motagally and Osman (2010); El-Awady *et al.* (2017)**.

As for the effect of the interaction among sowing dates and irrigation requirements on seed yield (kg/fed), results in Table 4 showed that, the interaction had a significant influence on seed yield in both seasons. Sakha 53 cultivar showed the highest value at the first sowing date (30th April) combined with the application of 100% IR (1975.05 kg/fed., in the first season and 1898.90 kg/fed., in the second season). On the contrary, planting Giza 102 cv. on June, 30th combined by 50% IR irrigation treatment, had the lowest values of seeds yield (kg/fed).

Seed Oil (%)

Results presented in Table 4 demonstrate that oil percentage of sunflower seeds was significantly governed by sowing dates. Sunflower seed oil percentage varied according to the different planting dates. In this respect and based on the results in Table 4, the highest seed oil (%) was obtained from planting on end-April (38.54 and 40.68 % in 1st and 2nd seasons, respectively) followed by end-May planting date (38.22 and 40.52% in 1st and 2nd seasons, respectively). Whilst lowest values were detected for seed oil percentage when sowing sunflower plants on end-June (35.15 and 37.45% in 1st and 2nd seasons, respectively). These results agree with those obtained by **Dutta (2011)**, **Sheoran *et al.* (2014), Hamza and Safina (2015), Dhillon *et al.* (2017) and Hemeid and Zeid (2020)**.

Regarding the effect of IR on sunflower seed oil percentage, results indicated that irrigation levels exerted a significant impact on such trait. The highest seed oil (%) was obtained in case of full irrigation requirement (40.54 and 42.84 % in 1st and 2nd seasons, respectively). The lowest seed oil percentage was observed in plots where irrigation with half irrigation requirement (50% IR). These results agree with those obtained by **Asbagh *et al.* (2009), Kazemeini *et al.* (2009), Alahdadi *et al.* (2011), Rauf *et al.* (2012), Ismail and El-Nakhlawy (2018), Ebrahimiana *et al.* (2019) and Patanè *et al.* (2017).**

Significant variations in seed oil percentage were detected between sunflower cultivars. The results revealed that Sakha 53 cv. was greater than Giza 102 cv. in seed oil percentage (11.43 and 11.04%) in 1st and 2nd seasons, respectively. These results agree with those obtained by **El-Sarag (2007), Abdel-Motagally and Osman (2010), El-Aref *et al.* (2011), Hamza and Safina (2015) and El-Awady *et al.* (2017).**

The interaction effect between sowing date, irrigation level and sunflower cultivars treatments also found significant (Table 4). The highest seed oil percentage was observed in plots sowed Sakha 53 cv. on April, 30th and provided with full irrigation (100% IR). Seed oil percentage was the lowest in case of plot planting with Giza 102 on June, 30th and stressed with half irrigation requirement (50% IR).

Oil Yield (kg/fed.)

The results showed that sowing dates was significantly affected on oil yield in both seasons. Sunflower oil yield took almost the same trend as the recorded yield and yield component results. Such trend was true in both experimental seasons 2018 and 2019. It was significantly and gradually decreased with delaying sunflower sowing date from end-April up to end-June. Reductions obtained in oil yield than the excelsior treatment of first sowing date (end-April) by the previous sowing dates were amounted to 52.22 and 45.31% (for second and third sowing dates, respectively in the first season. Analogous reduction values in the second season were 54.30 and 28.85% for second and third sowing dates, respectively. These results agree with those obtained by **Flagella *et al.* (2002), Vega and Hall (2002), Sheoran *et al*. (2014), Hamza and Safina (2015), Dhillon *et al.* (2017), Ozturk *et al.* (2017) and Demir (2019).**

Table 4. Effect of sowing dates, two sunflower cv., and irrigation treatments on seed yield, seed oil (%), oil yield and seed protein (%) in 2018 and 2019 seasons

Treatment			Seed yield (kg/fed.)		Seed oil (%)		Oil yield (kg/fed)		Seed protein (%)	
			Season							
			2018	2019	2018	2019	2018	2019	2018	2019
1. Effect of sowing date treatments										
April, 30			1471.38a	1466.72a	38.54 a	40.68 a	570.48 a	608.99 a	18.45 a	18.31 a
May, 30			1020.83b	1050.28b	38.22 b	40.52 a	392.59 b	433.24 b	16.54 c	16.44 c
June, 30			739.14 c	726.47 c	35.15 c	37.45 b	272.57 c	276.87 c	16.63 b	16.54 b
2. Effect of sunflower cultivars										
Sakha 53			1169.41a	1168.52a	39.56 a	41.86 a	470.63 a	495.72 a	16.14 b	16.05 b
Giza 102			984.82 b	993.79 b	35.04 b	37.24 b	353.14 b	383.68 b	18.28 a	18.15 a
3. Effect of irrigation treatments										
100% (control)			1348.01a	1318.97a	40.54 a	42.84 a	545.05 a	570.43 a	15.96 c	15.87 c
75%			1194.90b	1207.04b	36.96 b	39.26 b	456.06 b	484.20 b	16.90 b	16.80 b
50%			688.44 c	717.46 c	34.41 c	36.55 c	234.54 c	264.47 c	18.76 a	18.63 a
4. Interaction effect among sowing dates, sunflower cultivars, and irrigation treatments										
April, 30	**Sakha 53**	**100%**	1975.05a	1898.90a	43.12 a	45.42 a	350.03 g	412.30 f	15.02 p	14.93 n
		75%	1824.85b	1800.34b	39.87 ef	42.17 e	718.25 b	759.33 b	18.43 f	18.34 f
		50%	1019.05 f	1109.56e	34.86 i	37.16 h	841.56 a	862.67 a	20.34b	20.25b
	Giza 102	**100%**	1593.33c	1575.16c	39.63 f	41.93 e	276.13 hi	307.04 h	19.08 d	18.99 d
		75%	1554.68c	1541.52c	39.98 ef	42.28 de	613.62 c	651.88 c	16.99 i	16.90 i
		50%	861.31 g	874.86 g	33.79 j	35.12 i	623.30 c	660.69 c	20.84a	20.48a
May, 30	**Sakha 53**	**100%**	1292.35d	1322.17d	43.09 a	45.39 a	550.28 d	600.19 d	13.63 r	13.54 p
		75%	1192.18de	1254.90d	42.22 b	44.52 b	497.25 e	558.75 e	15.21 o	15.12 m
		50%	719.74 h	746.06 h	41.21 c	43.51 c	292.93 h	324.52 gh	15.86 m	15.77 k
	Giza 102	**100%**	1258.81 d	1254.75d	40.42 de	42.72 d	502.39 e	536.14 e	16.49 k	16.40 j
		75%	1011.64 f	1038.58ef	32.03 l	34.33 j	318.86 gh	356.43 g	17.83 g	17.74 g
		50%	650.29 h	685.22 h	30.32 m	32.62 k	193.84 j	223.41 j	20.19 c	20.10 c
June, 30	**Sakha 53**	**100%**	1092.39ef	991.75 f	40.94 cd	43.24 c	441.65 f	429.06 f	14.62 q	14.53 o
		75%	893.19 g	899.88 g	32.90 k	35.20 i	351.20 g	316.79 h	15.71 n	15.62 l
		50%	515.94 i	493.11 i	37.82 g	40.12 f	192.49 j	197.85 j	16.41 l	16.32 j
	Giza 102	**100%**	876.13 g	871.11 g	36.02 h	38.32 g	311.11 gh	333.86 gh	16.92 j	16.83 i
		75%	692.84 h	707.01 h	34.74 i	37.04 h	237.15 i	326.01 i	17.19 h	17.10 h
		50%	364.34 j	395.94 j	28.46 n	30.76 l	101.83 k	121.68 k	18.94 e	18.85 e

Mean values of treatments were differentiated by using Least Significant Range (Duncan's multiple range test) at 0.05 probability level

Concerning the effect of irrigation requirements (IR) on oil yield (kg/fed.), the results in Table 4 show that the oil yield was significantly reduced as the amount of applied irrigation water decreased. The average greatest oil yields (545.05 and 570.43 kg) were obtained from the highest irrigation level (100% IR), whereas the lowest oil yield (234.54 and 264.47 kg) was obtained from the 50% IR treatment in both experimental years. These results agree with those obtained by **Go¨ksoy *et al.* (2004), Asbagh *et al.* (2009), Kazemeini *et al.* (2009), Alahdadi *et al.* (2011), Rauf *et al.* (2012), Mobasser and Tavassoli (2013), Patanè *et al.* (2017) and Ebrahimiana *et al.* (2019).**

Regarding sunflower cultivar, Sakha 53 was produced the highest oil yield (470.63 and 495.72 kg/fed in 1st and 2nd seasons, respectively). Conversely, Giza 102 gave the lowest values of oil yield (353.14 and 383.68 kg/fed in 1st and 2nd seasons, respectively) in both seasons, respectively. Oil yield (kg/fed) of Sakha 53 was significantly higher than Giza 102 sunflower cultivar in the first season by 24.96% and in the second season by 22.60%. These results agree with those obtained by **Abdel-Motagally and Osman (2010), El-Aref *et al*. (2011), Hamza and Safina (2015) and El-Awady *et al.* (2017)**.

As for the effect of the interaction effect between sowing dates, irrigation requirements and sunflower cultivars on oil yield (kg/ fed), results in Table 4 show that, the interaction had a significant influence on oil yield in both seasons. Sakha 53 cultivar showed the highest value at the first sowing date (30th April) with the application of 100% IR (841.56 kg/fed in the first season and 862.67 kg/fed in the second one). On the contrary, planting Giza 102 cv. on June, 30th combined by 50% IR irrigation treatment, had the lowest values of oil yield (101.83 and 121.68 kg/fed in 1st and 2nd seasons, respectively).

Seed Protein Percentage (%)

Sunflower seed protein content varied according to the different planting dates. The least sowing date (30th June) gave the highest values of seed protein percentage which exceeded those obtained values with the other tested sowing dates (30th April and 30th May) in the first season by 10.35 and 9.86 %, and 9.66 and 7.28 % in second season, respectively. These results agree with **Dhillon *et al.* (2017**).

The effect of rate of irrigation requirement on seed protein percentage was statistically significant ($p<0.05$). The protein percentage in the produced oil took another trend compared to the oil yield. The oil protein percentage was increased gradually with decreasing irrigation level. The highest protein percentage (18.76 and 18.63 % in the 1st and 2nd seasons, respectively) was obtained by half irrigation requirement (50% IR). Whereas the lowest seed protein percentage was observed in plots which irrigated by full irrigation requirement (100% IR). Irrigated sunflower plants with half irrigation requirements lead to increase seed protein percentage in first season by 9.91% and 14.93% for 75 and 100% IR, respectively and by 9.82% and 14.81% for 75 and 100% IR, respectively in the second season.

These results agree with **Alahdadi *et al.* (2011); El Awady *et al.* (2017)** and **Kosar *et al.* (2021)**. Also, **Feng *et al.* (2021)** noted that there were increasing in amino acids then decreased gradually. Generally, a reduce in irrigation water improved seed protein content.

Significant variations in seed protein percentage were detected between sunflower cultivars. Results indicate that the highest value of protein percentage was recorded from obtained Giza 102 cv. (18.28 and 18.15% in 1st and 2nd seasons, respectively). While Sakha 53 cv. gave the lowest protein percentage (16.14 and 16.05% in 1st and 2nd seasons, respectively). Protein percentage of the potent sunflower cultivar Giza 102 significantly exceeded that of Sakha 53 cv. treatment in the first season by 11.70% and in the second season by 11.57%. These results agree with those obtained by **El-Aref *et al.* (2011)** who reported that plants of Sakha-53 were superior significantly than Giza-102 in protein percentage. On the other contrary, **El -Awady *et al.* (2017)** found that the Giza 102 was superior to Sakha 53 variety in protein percentage. May be due to different climatic conditions.

Results of the interaction among sowing dates, irrigation level treatments and sunflower cultivars showed that the early sowing date (30th April) combined by limited irrigation level (50% irrigation) gave the highest protein percentage. But the lowest value was obtained with combination of April, 30th, Giza 102 and 50% IR (Table 4).

Fatty Acid Composition (FAC %)

Results in Tables 5 and 6 revealed that the interaction between sowing date, irrigation requirements as well as sunflower cultivars had significant effect on fatty acid composition (%) of extracted sunflower seeds oil during the two growing seasons. Fatty acid composition (%) consists of i) total saturated fatty acids (TSFA) which ranged between 3.42 to 6.25%, ii) monounsaturated fatty acids (MUSFA) which ranged between 55.64% to 73.85% and iii) polyunsaturated fatty acids (PUSFA) which ranged between 23.37 to 40.77% in the first season. While, in the second season, total saturated fatty acids (TSFA) ranged between 6.59, 10.75%, monounsaturated fatty acids (MUSFA) ranged between 50.99% to 68.91% and polyunsaturated fatty acids (PUSFA) ranged between 22.52 and 38.92%.

It is clear that, the highest value for each of TSFA and MUSFA was recorded during the least sowing date in both cultivated seasons, followed by the second sowing date. PUSFA took the opposite trend in both seasons.

Results demonstrated that delaying sowing date beyond 30th April was accompanied with a gradual increase in values of TSFA % and MUSFA (%). Therefore, June 30th planting date treatment achieved the highest values of TSFA (%) and MUSFA (%). Whereas sowing on April 30th gave the lowest values. On the contrary, the highest value of PUSFA (%) was obtained with early sowing date, while the delayed sowing date decreased the PUSFA (%) in 1st and 2nd seasons. This trend was fact in the two experimental seasons.

Significant effect of irrigation treatments on fatty acids percentage, was evaluated. The maximum TSFA and PUSFA percentages were observed in plots where irrigation with full irrigation requirement (100% IR) compared to the other irrigation requirement treatments. The MUSFA percentage in two experimental seasons were recorded maximum percentage in case of half irrigation requirement (50% IR) compared to 100% IR. Also, results showed that Sakha-53 cultivar is suitable for obtained healthier oils with high UFA and low TSFA. But Giza-102 cultivar gave the highest TSFA percentage and lower USFA% in both experimental seasons.

Generally, results indicated that the late sowing date (30th June) combined with Giza-102 which irrigated with full irrigation level (100% irrigation) gave the highest TSFA (%). The highest ratio of MUSFA (%) was recorded when planting Sakha-53 combined with planting on June 30th and 50% IR interaction treatments. Meanwhile, the PUSFA (%) was increased with planting on April, 30th combined with Giza 102 which applied with the full irrigation requirement (100% IR).

These results are agreed with **Saleem *et al.* (2008) and Zheljazkov *et al.* (2009)**

Table 5. The interaction effect among different planting dates and irrigation treatments on fatty acid composition (FAC; %) of sunflower cultivars in 2018 season

Treatment			Behenic acid (C22:0)	Arachidic acid (C20:0)	Stearic acid (C18:0)	Palmitic acid (C16:0)	Myristic acid (c14:0)	TSFA	Gadoleic acid (C20:1)	Palmitoleic acid (C16:1)	Oleic acid (C18:1)	MUSFA	Linoleic acid (C18: 2n6c)	α-Linolenic acid (C18:3)	PUSFA
April, 30	Sakha 53	50%	0.36 b-e	0.18 m	0.56 m	2.21 p	0.10 m	3.42 g	0.15 i	3.98 r	60.42 g	64.56 i	32.94 e	0.03 i	32.98 e
		75%	0.32 de	0.19 l	0.61 k	2.50 k	0.15 i	3.78 f	0.14 j	4.80 m	58.66 j	63.61 l	33.40 d	0.07 f	33.48 d
		100%	0.12 f	0.20 k	0.65 g	2.5 k	0.37 d	3.85 f	0.10 k	5.01 l	55.88 l	60.99 n	35.01 b	0.10 c	35.11 b
	Giza 102	50%	0.40 b-e	0.22 i	0.58 l	2.68 j	0.07 o	3.96 f	0.20 d	4.75 o	62.56 e	67.52 f	29.44 i	0.05 g	29.50 i
		75%	0.34 cde	0.27 f	0.63 i	2.87 h	0.11 l	4.23 e	0.17 g	5.073 k	59.76 i	65.01 h	31.34 g	0.09 d	31.44 g
		100%	0.32 de	0.31 e	0.69 f	2.92 g	0.27 e	4.52 d	0.15 i	5.56 d	49.92m	55.64 o	40.64 a	0.12 a	40.77 a
May, 30	Sakha 53	50%	0.42 b-e	0.21 j	0.61 k	2.26 o	0.08 n	3.59 g	0.20 d	4.52 p	65.21 b	69.94 b	27.36 l	0.02 j	27.39 l
		75%	0.32 de	0.22 i	0.65 g	2.50 k	0.11 l	3.81 f	0.18 f	4.76 n	62.69de	67.64 f	29.35 i	0.05 g	29.41 i
		100%	0.30 e	0.51 a	0.72 d	3.46 d	0.41 c	5.41 c	0.16 h	5.24 i	58.85 j	64.26 j	31.34 g	0.09 d	31.44 g
	Giza 102	50%	0.50 ab	0.21 j	0.62 j	2.46 l	0.12 k	3.92 f	0.25 b	5.40 h	62.53 e	68.19 e	28.77 j	0.02 j	28.80 j
		75%	0.38 b-e	0.26 g	0.69 f	2.73 i	0.20 h	4.27 e	0.20 d	5.52 f	58.66 j	64.39 ij	32.17 f	0.04 h	32.22 f
		100%	0.37 b-e	0.41 c	0.75 c	3.54 c	0.41 c	5.49 c	0.18 f	5.55 e	55.77 l	61.51 m	33.80 c	0.10 b	33.91 c
June, 30	Sakha 53	50%	0.48 abc	0.18 m	0.58 l	2.43 m	0.14 j	3.82 f	0.25 b	4.26 q	69.33 a	73.85 a	23.35 m	0.01 k	23.37m
		75%	0.35 b-e	0.24 h	0.71 e	3.13 e	0.23 g	4.67 d	0.23 c	5.61 c	62.89 d	68.74 d	27.44 l	0.04 h	27.49 l
		100%	0.33 cde	0.39 d	0.78 b	3.93 b	0.46 b	5.9 b	0.19 e	5.83 b	60.17 h	66.20 g	28.69 j	0.07 f	28.77 j
	Giza 102	50%	0.61 a	0.27 f	0.61 k	2.30 n	0.15 i	3.95 f	0.29 a	5.13 j	63.76 c	69.19 c	27.77 k	0.01 k	27.79 k
		75%	0.46bcd	0.31 e	0.64 h	3.00 f	0.25 f	4.67 d	0.23 c	5.42 g	61.82 f	67.48 f	28.74 j	0.03 i	28.78 j
		100%	0.42 b-e	0.47 b	0.85 a	4.01 a	0.49 a	6.25 a	0.18 f	6.38 a	57.42 k	63.99 k	30.48 h	0.08 e	30.57 h

- **Mean values of treatments were differentiated by using Least Significant Range (Duncan's multiple range test) at 0.05 probability level**

Table 6. The interaction effect among different planting dates and irrigation treatments on fatty acid composition (FAC; %) of sunflower cultivars in 2019 season

Treatment			Behenic acid (C22:0)	Arachidic acid (C20:0)	Stearic acid (C18:0)	Palmitic acid (C16:0)	Myristic acid (c14:0)	TSFA	Gadoleic acid (C20:1)	Palmitoleic acid (C16:1)	Oleic acid (C18:1)	MUFA	Linoleic acid (C18:2n6c)	α-Linolenic acid (C18:3)	PUFA
April, 30	Sakha 53	50%	0.53 n	0.15 l	2.13 p	3.69 r	0.07 m	6.59 r	0.14 i	0.19 g	60.12 i	60.46 i	31.50 e	0.02 g	31.53 e
		75%	0.60 j	0.16 k	2.32 m	4.43 m	0.10 j	7.63 n	0.13 j	0.13 k	57.92 n	58.19 n	32.66 d	0.06 d	32.73 d
		100%	0.63 g	0.18 j	2.36 k	4.67 j	0.33 b	8.19 j	0.09 k	0.09 o	56.37 p	56.56 p	33.70 c	0.09 b	33.80 c
	Giza 102	50%	0.55 m	0.19 i	2.40 i	4.45 l	0.04 o	7.65 m	0.19 d	0.23 e	61.75 f	62.18 g	28.70 j	0.04 e	28.75 j
		75%	0.60 j	0.24 f	2.59 g	4.40 n	0.08 l	7.93 k	0.16 g	0.14 j	59.77 j	60.08 j	30.50 h	0.06 d	30.57 h
		100%	0.66 f	0.28 e	2.84 f	4.66 k	0.21 e	8.67 g	0.14 i	0.11 m	50.73 r	50.99 r	38.80 a	0.11 a	38.92 a
May, 30	Sakha 53	50%	0.58 l	0.18 j	2.18 o	4.22 o	0.05 n	7.23 p	0.19 d	0.22 f	64.39 b	64.81 b	26.52 p	0.01 h	26.54 p
		75%	0.62 h	0.19 i	2.35 l	4.21 p	0.08 l	7.47 o	0.17 f	0.12 l	62.25 e	62.55 e	28.51 k	0.04 e	28.56 k
		100%	0.73 c	0.48 a	2.98 d	4.74 h	0.28 c	9.23 d	0.15 h	0.10 n	58.31 m	58.57 m	30.70 g	0.09 b	30.80 g
	Giza 102	50%	0.59 k	0.18 j	2.38 j	5.10 d	0.09 k	8.36 i	0.24 b	0.30 b	61.69 g	62.24 f	27.93 m	0.01 h	27.95 m
		75%	0.66 f	0.23 g	2.55 h	4.92 f	0.17 g	8.55 h	0.19 d	0.18 h	58.82 l	59.20 l	30.79 f	0.03 f	30.83 f
		100%	0.72 d	0.38 c	3.36 b	4.75 g	0.28 c	9.51 c	0.17 f	0.14 j	54.93 q	55.25 q	33.72 b	0.09 b	33.82 b
June, 30	Sakha 53	50%	0.55 m	0.15 l	2.35 l	3.96 q	0.11 i	7.14 q	0.24 b	0.28 c	68.38 a	68.91 a	22.51 r	0.005 i	22.52 r
		75%	0.68 e	0.21 h	2.55 h	5.11 c	0.20 f	8.77 f	0.22 c	0.15 i	63.79 c	64.17 c	25.60 q	0.03 f	25.64 q
		100%	0.75 b	0.36 d	3.65 a	5.43 b	0.33 b	10.54 b	0.18 e	0.13 k	59.20 k	59.52 k	28.45 l	0.06 d	28.52 l
	Giza 102	50%	0.58 l	0.24 f	2.22 n	4.73 i	0.12 h	7.91 l	0.28 a	0.41 a	62.67 d	63.37 d	27.29 o	0.005 i	27.30 o
		75%	0.61 i	0.28 e	2.85 e	5.02 e	0.22 d	9.0 e	0.22 c	0.24 d	61.28 h	61.75 h	27.78 n	0.02 g	27.81 n
		100%	0.82 a	0.44 b	3.33 c	5.78 a	0.36 a	10.75 a	0.17 f	0.19 g	57.04 o	57.41 o	30.34 i	0.07 c	30.42 i

- **Mean values of treatments were differentiated by using Least Significant Range (Duncan's multiple range test) at 0.05 probability level** who found that later planting dates increased TSFA, stearic acid and linoleic acid. As well as **Dhillon *et al.* (2017)** found that delaying sowing date decreased linoleic acid and increased oleic acid. The palmitic acid, stearic acid, oleic and linoleic acid were significantly affected by drought stress (**Sezena *et al.*, 2011)**. An increasing in oleic acid and a decreasing in linoleic acid, palmitic acid and stearic acid contents that doing cause to drought stress **(Kosar *et al.*, 2021)**.

Conclusion

Increasing air temperatures degree recorded less linoleic acid but achieve the highest oleic acid. Full irrigation requirement treatment (100% IR) was achieving higher seed and oil yields. Sakha-53 is very suitable for growing under North Sinai conditions because it is surpassed Giza-102 cultivar in all studied traits.

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الملخص العربي

تأثير مواعيد الزراعة ومعاملات الري على محصول البذور ومكونات الزيت لصنفين من دوار الشمس تحت ظروف شمال سيناء

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هدفت هذه الدراسة الى التعرف على صنف دوار الشمس المناسب زراعته تحت ظروف شمال سيناء والذي يعطي أفضل محصول من البذور والأحماض الدهنية تحت مواعيد زراعية (30 أبريل ، 30 مايو ، 30 يونيه) واحتياجات مائية مختلفة (50%، 75% ، 100%). أجريت هذه الدراسة خلال موسمين زراعيين متتاليين 2018 و 2019م في المزرعة التجريبية لكلية العلوم الزراعية البيئية، جامعة العريش، شمال سيناء، مصر. وأظهرت النتائج حدوث زيادة ملحوظة في محصول الزيت مع الزراعة المبكرة (30 أبريل). وأيضًا تم الحصول على زيوت صحية تحتوى على نسبة مرتفعة من الأحماض الدهنية غير المشبعة وأقل نسبة من الأحماض الدهنية المشبعة عند الزراعة المبكرة في 30 أبريل. بينما ادى ميعاد الزراعة المتأخرة (30 يونيه) للحصول على أعلى نسبة من الأحماض الدهنية المشبعة. في حين أدى ري نباتات دوار الشمس باستخدام 75% و 50% من الإحتياجات المائية الى تأثر النباتات بإجهاد مائي ما بين متوسط الى شديد، لذلك فإن معاملة إحتياجات الري الكاملة (100%) حققت أعلى محصول اقتصادي من البذور ومكونات الزيت الكيميائية. في حين أن خفض الاحتياجات المائية الى 50% ينتج عنه زيت غني بالأحماض الدهنية غير المشبعة وأقل نسبة من الأحماض الدهنية المشبعة. من ناحية أخرى، سجل نبات دوار الشمس صنف سخا 53 أعلى نسبة من محصول الزيت مقارنة بصنف جيزة 102. وفيما يتعلق بتأثير التفاعل بين مواعيد الزراعة ومعاملات الإحتياجات المائية وأصناف دوار الشمس، أشارت النتائج ألى أن زراعة صنف سخا 53 في نهاية أبريل والري بمعدل 100% من الإحتياجات المائية يعطي أكبر كمية من محصول البذور ومحصول الزيت يليه زراعة صنف سخا 53 في نهاية أبريل والري بمعدل 75% من الإحتياجات المائية. على العكس من ذلك، فزراعة صنف جيزة 102 في 30 يونيه والري بنسبة 50% من الإحتياجات المائية سجل أقل القيم في الموسم الأول والموسم الثاني.

الكلمات الإسترشادية: دوار الشمس، مواعيد الزراعة، الاحتياجات المائية، أصناف دوار الشمس، مكونات الزيت.

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