SINAI Journal of Applied Sciences 12 (2) 2023 151-162

Available online at www.sinjas.journals.ekb.eg

SCREENED BY SINAI Journal of Applied Sciences

iThenticate Professional Plagiarism Prevention

Print ISSN 2314-6079
Online ISSN 2682-3527

ARU-EGYPT SJAS TrustScience | ItCreates

RESPONSE OF TWO SUNFLOWER CULTIVARS TO SOWING DATES AND IRRIGATION TREATMENTS UNDER NORTH SINAI CONDITIONS

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ARTICLE INFO

Article history:
Received: 24/02/2023
Revised: 13/03/2023
Accepted: 12/04/2023

Keywords:
Sunflower, Sowing dates, Irrigation requirements, Sakha-53, Giza-102.

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ABSTRACT

This study was investigated the effect of sowing dates (30th April, 30th May and 30th June), irrigation requirements (50%, 75%, 100% IR), sunflower cultivars (Sakha-53 and Giza-102) and their interactions on sunflower growth, yield and its components. The results showed that plant growth and yield were increased with early sowing date (30th of April). But delayed June 30th planting date treatment achieved the highest averages of leaves proline content. Reduce water to 50% IR treatment is not suitable for development sunflower and seed yield. Sakha-53 produced significantly higher plants vegetative growth and biological yield than Giza-102. Finally, data revealed that planting sunflower cv. Sakha-53 in end- April using 100% IR followed by 75% IR gave the highest value for each of plant growth, seed-yield and yield components.

INTRODUCTION

Now, Egypt needs to increase agricultural production of the sunflower crop to reduce edible oil imports. But there are many problems confronting this goal. Climate change especially increases in air temperature has greatly affected the agricultural sector and will lessen the capacity of agricultural production in Egypt and will modify locations of cultivation (**Negm, 2019**). Thus, the time of planting is one of the important factors in achieving maximum sunflower yield, which can differ significantly between early sowing (spring) or late sowing (summer) (**Qadir *et al.*, 2007**).

Delaying sowing date of sunflower cause decrease in head characterize and seed-weight. Also, heights yield of sunflower seeds was recorded with early sowing date **(Mourad and El Mehy, 2021)**. Also, **Saudy *et al.* (2021)** reported that early sowing (April 21) exhibited corresponding increases in seed yield in both seasons. Tallest plant and highest yield were recorded when Sakha-53 cv. was planted on new reclaimed soil **(Hamza and Safina 2015)**.

On the other hand, limited water sources and low rainfall is another major challenge of the agricultural sector in Egypt. The water requirements of sunflower are expected to increase which vary now from 600 to 1000 mm **(Allam and Gamal, 2007; Negm, 2019; FAO, 2020)**. 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)**. This finding is in agreement with **Keipp *et al.* (2020)** that found seed number per plant was unaffected with reducing irrigation water,

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https://doi.org/10.21608/SINJAS.2023.194202.1188

but a lower seed-weight was recorded. At final harvest significantly suppressed the yield / sunflower plant, but seed-number/ plant was unaffected.

Therefore, solutions must be found at the farm level which can be reduce the effect of climatic change, through changes in planting dates, cultivars, and irrigation intervals or requirements. Thus, the aim of this study was investigate the effect of three planting dates, three irrigation requirements (IR), and two sunflower cultivars on plant growth, seed-yield, and oil percentage of sunflower.

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 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 among 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 sowing. Drip irrigation system was using. A split-spilt plot layout design was used as, 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.

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%.

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

Month	Temperature °C			Humidity	Wind speed	Sol. Radiat.	Rainfall	Eto
	Max	Min	Mean	(%)	km/day	$MJ/m^2/day$	(mms)	mm/day
				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 seasons

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

The plants were protected from attack bird's using paper to cover heads. About sixty days from planting, random eight plants were taken to record plant height, number of leaves/plant. The No. days from planting to completion of 75% flowering and days to 90% maturity were recorded for the crop in each plot and average was calculated.

At harvest, total plant dry weight (g) was recorded. The harvesting started when signs of maturity were observed, the back of the head turns black, and brackets turned to brown. After two weeks from harvest the seeds were air dried to determine the following yield parameters such as seed-weight/plant (g), seed number/plant computed by multiplying (seeds-weight per plant/ 100- seed weight) by 100, 100- seed weight (g), then seed-yield (kg fed.$^{-1}$) computed by multiplying seed wt./m^2 by 4200 m^2.

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

Effect of Sowing Dates

Under experimental conditions results showed that the tallest plants of sunflower (149.77 and 152.35 cm, for 1st and 2nd seasons, respectively) were that sown on April, 30 which significantly exceeded those of 30th May by 4.74% and 5.26% and 30th June sowing dates by 20.62% and 20.22% (1st and 2nd seasons, respectively). Also, delaying sowing date to 30th May or 30th June led to a gradual reduction in number of leaves per plant than that of early sowing in the 1st season by 8.92 and 21.29%, for 2nd and 3rd planting dates, respectively. Analogous decreases were amounted to 6.26 and 17.60%, for the 2nd and 3rd planting date, respectively in the 2nd season.

Sunflower plant dry weight was gradually decreased as sowing date delayed from April 30th to June 30th. Also, the first sowing date exhibited the highest No. days to 75% flowering (66.16 and 67.66 days in the 1st and 2nd seasons, respectively). Days to 75% flowering of such potent treatment outnumbered those obtained by 30th May and 30th June sowing date treatments in the first season by 3.00 and 4.16%, respectively and in the 2nd one by 4.16 and 9.38%, respectively. On the same trend, the longest No. days to maturity date (86.66 and 85.00 days) was reached on the 30th of April sowing date compared to the 30th of June where their values were 80.66 and 80.33 days for 1st and 2nd seasons, respectively.

Greatest head diameter value was achieved by the 30th April sowing date in both seasons. Sunflower plants sown at the 30th April recorded the highest number of seeds/ head in both seasons. Delaying planting date to end-May and end-June significantly decreased head diameter values in the 1st season by 17.63 and 34.30%, respectively. Analogous decreases in the 2nd season were 18.34 and 31.48%, respectively.

Seed weight /plant value of such potent treatment outweighed those obtained from end-May and end-June sowing dates in the first season by 30.62 and 49.77%, respectively; in the 2nd season by 28.40 and 50.47%, respectively. Seed index of such potent treatment surpassed those of end-May and end-June sowing date treatments in the 1st season by 15.47 and 30.14%, respectively. Analogous increases values in the second season were 12.11 and 28.06%, respectively.

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 2nd season were 28.39 and 50.47% in end-May and end-June, respectively. Delaying planting date after 30th April was gradual increase in values of leaves proline content. Therefore, June 30th planting date treatment achieved the highest averages of leaves proline content, whereas the lowest ones were obtained from sowing on April 30th, in both seasons.

Highest value of WUE was recorded with 30th April sowing date followed by 30th May and finally by 30th June in both successive seasons of 2018 and 2019. The WUE values of first sowing date 30th April were significantly performed better than the other later sowing dates in the 1st season by 27.86 and 44.26% than the second and third sowing dates, respectively. Comparable increases obtained by the same early sowing date treatment in the 2nd season were amounted by 27.41 and 28.00 % over than the second and third sowing dates, respectively.

The early sowing date superiority than late sowing date may be due to adaptive cultivars to air temperature in April. This can give the good vegetative growth of sunflower plant. On the other hand, late sowing date gave the short plant growth season **(Ferguson *et al*., 1990)**. These finding explained prefer sunflower plant to growth, development and completed their life cycle *versa vice*, sunflower planting at June **(Ozturk *et al*., 2017; Saudy *et al*., 2021)**.

These results are in agreement with those reported by **El-Sadek *et al*. (2004)** who stated that plant height and growth were decrease due to delay planting date to beginning summer season. Also, decrease in number of seeds per head accompanied with the late sowing dates may be due to produced heads of small size, gave minimum number of seeds per head **(Baghdadi *et al*., 2014)**.

Effect of Irrigation Requirement Treatments

Plant height reduced by 0.37 and 26.72%, for 75% IR and 50% IR treatments, respectively, compared to 100% IR during the first growing season. While in 2nd season, plant height took another trend, 75% IR increased plant height by 0.46% compared to 100% IR but 50% IR treatment reduced plant height by 23.40%. Whereas the 100% of irrigation requirement gave the highest number of leaves followed by 75% of IR treatment. The 75% IR and 50% IR treatments reduced number of leaves by 3.60 and 16.86%, respectively in the first season. On the same trend, the 75% IR and 50% IR treatments reduced number of leaves by 1.46 and 14.37%.

Total plant dry weight and number of days to 75% flowering of sunflower plants were increased by increasing the amount of irrigation requirements up to 100% IR followed by 75% of IR treatment in both seasons. Number of days to 75% flowering of well-irrigated (100% IR) treatment surpassed that of 75% IR by 4.17% and 50% IR by 9.50% in 1st season and by 3.12% and 4.29%, respectively in 2nd season. Results pointed out that, the number of days to the maturity date of such potent treatment outnumbered those of 75% and 50% irrigation levels by 8.71% and 13.72%, respectively in the first season and by 8.88% and 13.98%, respectively in the second one.

Hence, applying 100% of the irrigation requirement secured the highest values (23.72 and 23.94 cm for 1st and 2nd seasons, respectively) followed by 75% of IR treatment. Whereas decreasing the water supply requirement down to 50 percentage IR cause a gradual reduction in head diameter (12.61 and 13.64 cm for 1st and 2nd seasons, respectively).

Whereas No. seeds per head and seed -weight/head were decreased by increasing the stress water. Also, 100-seed weight were significantly increased by increasing applied irrigation. Therefor 100% IR produced the highest weight of 100-seed (6.15 and 6.61 g) in the two seasons, whereas 50% IR produced the least weight of 100-seed weight (4.40 and 5.03 g) in 1st and 2nd seasons, respectively.

On the same line, the seed-yield was significantly gradually reduced with decreasing IR quantity. The greatest seed-yield (1348.01 and 1318.97 kg/fed.) were obtained from 100% IR. Whereas, leaves proline content decreased as irrigation levels were increased. Therefore, the highest proline values (16.24 and 16.81 mg/100g fresh weight (FW) in the two seasons were observed in leaves of 50% IR.

The WUE value was essentially judged by irrigation requirement. Obtained results observed that WUE values were increased as irrigation level increased up to 75% IR. Increase irrigation level to 100% IR led to decrease WUE sharply. The highest value in second season of WUE was achieved by deficit irrigation (75% IR) followed by 50% IR. Lowest value of WUE was recorded with 100% IR. In this concern, WUE value of limited irrigation (75% IR) treatment exceeded those of 50% and 100% IR treatments in the 1st season by 15.68 and 13.72%, respectively and in the 2nd season by 21.73 and 11.53 %, respectively.

These results may be referred to that decreasing the irrigation water level decreased the available soil moisture in the root zone of plants which in turn reduce the transpiration from plant canopy and the evaporation from the soil surface as well. These results agree with those obtained by **Saeed *et al.* (2015)** they indicated that increasing the amount of irrigation water significantly increased leaves weight and all growth and yield traits on plant. Also, **Yawson *et al*. (2011)** and **Kosar *et al.* (2021)** noted that increasing irrigation quantity was necessary to increase photosynthesis process, growth and development plant, meanwhile, drought stress significantly suppressed the plant growth and seed yield in sunflower.

Effect of Sunflower Cultivars

Depending on the ability of sunflower cultivars to adapt to temperature conditions, the plant heights were significantly different between the two cultivars for both years. In the first year Sakha-53 (156.74 cm) produced significantly taller plants than Giza 102 (117.48 cm). Second season took the same trend; Sakha-53 gave the highest plant height (158.55 cm). In the same trend results indicated that Sakha-53 cv. gave high mean of number of plant leaves (23.66 and 26.07, in 1st and 2nd season, respectively).

Sakha-53 recorded higher total plant dry weight (804.07 and 821.77 g) in the two seasons and achieved the longest number of days to 75% flowering value (70.66 and 70.00 days). While Sakha- 53 cv. surpassed Giza 102 sunflower cultivar treatment in the 1st season by 13.22%, and in 2nd season by 16.22% of the number of days to maturity date.

Concerning sunflower cultivars, in comparison to the two-year head diameter results of sunflower cultivars, Sakha-53 cv. had the highest head diameters (20.14 and 20.72 cm). Giza 102 cv. sunflower cultivar sown on the first sowing date gave the highest number of seeds /head (1007.81), but Sakha 53 gave the lowest value (981.74). On the other hand, differences between sunflower cultivars treatments were non-significant for the number of seeds/head in the second season. Obtained results suggested that sunflower Sakha-53 cultivar achieved the highest seed weight per head compared with Giza 102.

Also, Sakha-53 produced the highest 100-seed-weight (5.78 and 6.34 g.). Conversely, Giza 102 gave the lowest values of 100-seed weight (4.85 and 5.38 g). Conversely, seed yield (kg/fed) and leaves proline content of Sakha 53 significantly was higher than those obtained by Giza 102 of sunflower cultivars treatments in the 1st and 2nd seasons.

Significant variations in WUE were detected among sunflower cultivars in both seasons. Sakha-53 cv. gave the highest WUE (0.50 and 0.51 kg/m^3 in 1st and 2nd seasons, respectively). While Giza 102 sunflower cultivar gave the lowest water use efficiency with values 0.42 and 0.43 kg/m^3 in 1st and 2nd seasons, respectively. Where, Sakha 53 cultivar gave the highest seed yield to its superior yield components, which significantly exceeded that of Giza 102 sunflower cultivar treatments in 1st season by 16.0%, and in the 2nd season by 15.68%.

These results due to the variation between cultivars in genetic makeup **(El-Aref *et. al*., 2011)**. Also, Sakha-53 and its capability to North Sinai climatic and soil than Giza- 102 cv. Also, **Abdel-Motagally and Osman (2010)** and **Hamza and Safina (2015)** recommended that cultural Sakha-53 cultivar in new reclaimed soil because its significantly higher growth and yield than Giza -102 and other cultivars.

Interaction Effect among Treatments

A significant difference between studied treatments during the two successive growing seasons. Results revealed that in both seasons, planting sunflower cv. Sakha-53 on end-April or end-May using 100% IR and 75% IR irrigation treatments gave the highest increase in the plant height (181.66, 187.00, 182.66 and 184.66 cm), respectively, in the first season. On the same line in 2nd season plant height record (181.66, 183.00, 180.33 and 185.22 cm). While the shortest plant recorded when using 50% IR with sunflower cv. Giza- 102 planted on end-May or end-June in both seasons. Meanwhile, Sakha- 53 plants are optimal grow when planted on April, 30 and 100%IR recorded the highest number of leaves.

The highest mean values of total plant dry weight (g), longest No. days to 75% flowering and longest No. days to maturity date were found for the interaction Sakha-53 combined by 30th April sowing date and 100% IR and Sakha-53 × end-April × 75% IR in both seasons, respectively.

Also results showed that the highest mean values of head diameter (28.66 and 28.40 cm in 2018 and 2019 seasons, respectively) were obtained by the combination of April 30th with 100% IR and Sakha-53, but the lowest head diameter (9.66 and 10.95 cm in the first and second seasons, respectively) produced from the combination of June, 30th with 50%IR and Giza- 102.

The highest number of seeds/plant in 2018 season were obtained with April, 30th sowing date combined with Sakha-53 and 100% IR, or April, 30th sowing date combined with Sakha-53 and 75% IR, and April, 30th combined with Giza-102 and 75% IR (1359.73, 1341.26 and 1354.83, respectively). But the second seasons had another trend where the highest number of seeds per head were obtained by planting Giza-102 on April, 30th with 75% IR (1280.99) followed by planting Sakha-53 on April, 30th using 100% or 75% IR, (1246.00 and 1240.72, respectively).

The highest mean of seeds weight/head was obtained by Sakha-53 cultivar planting on April 30th + 100%IR. Thus, the highest yield of seeds (kg/fed) were recorded with Sakha-53 combined with the application of 100% IR (1975.05 kg/fed in the first season and 1898.90 kg/fed in the second season). While Sakha-53 cultivar plants sown on the 30th June and irrigated with 50% irrigation requirement gave the highest values of leaves proline content (17.95 mg/100g F.W.) in 2018 season and 18.52 (mg/100g F.W.) in 2019 season.

First sowing date (30th April) combined with 75% IR with Sakha-53 sunflower cultivar treatments had the highest WUE values (0.75 and 0.74 kg/m3) for 2018 and 2019 seasons, respectively compared to other interacted treatments. The lowest WUE value was recorded by the lately sowing date (30th June) combined with 100% IR treatments with Giza-102 sunflower cultivar (0.30 and 0.30 kg/m^3 in 1st and 2nd seasons, respectively).

Table 4. Effect of sowing dates and irrigation on vegetative traits, phenological parameters and proline content of two sunflower cultivars at 2018 and 2019 seasons

Treatment			Plant height (cm)		leaves number/plant		Total plant weight (g)		Days to 75% flowering		Days to 90% maturity		Leaves proline content (mg/100g FW)	
			2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
1. Effect of the sowing dates														
April, 30			149.77 a	152.35 a	25.55 a	27.44 a	834.93 a	852.13 a	66.16 a	67.66 a	86.66 a	85.00 a	11.4 c	11.4 b
May, 30			142.66 b	144.33 b	23.27 b	25.72 b	781.61 b	801.17 b	63.16 b	63.50 b	82.00 b	79.00 c	14.53 b	14.53 a
June, 30			118.88 c	121.53 c	20.11 c	22.61 c	684.30 c	703.63 c	62.00 c	58.28 c	80.66 c	80.33 b	15.6 a	15.39 a
2. Effect of sunflower cultivars														
Sakha 53			156.74 a	158.55 a	23.66 a	26.07 a	804.07 a	821.77 a	70.66 a	70.00 a	91.22 a	89.55 a	14.53 a	14.50 a
Giza 102			117.48 b	120.25 b	22.29 b	24.44 b	729.82 b	749.51 b	56.88 b	56.30 b	75.00 b	73.33 b	13.39 b	13.11 b
3. Effect of irrigation														
100% (control)			150.72 a	150.94 a	24.66 a	26.66 a	805.14 a	818.50 a	68.33 a	65.62 a	89.83 a	88.16 a	11.97 c	11.40 c
75%			150.16 a	151.64 a	23.77 b	26.27 b	792.94 b	811.88 a	64.16 b	62.50 b	82.00 b	80.33 b	13.68 b	13.11 b
50%			110.44 b	115.62 b	20.50 c	22.83 c	702.76 c	726.55 b	58.83 c	61.33 c	77.50 c	75.83 c	16.24 a	16.81 a
4. Interaction effect among sowing dates and irrigation treatments on the two sunflower cultivars.														
April, 30	**Sakha 53**	**100%**	181.66 a	181.66 a	28.00 a	29.60 a	911.56 a	924.25 a	80.00 a	79.33 a	107.66 a	106.00 a	8.26 g	9.69 hi
		75%	187.00 a	183.00 a	27.00 ab	29.00 ab	907.40 a	915.43 a	75.00 c	74.33 c	95.66 d	94.00 d	11.68 f	10.83 f-i
		50%	150.33 b	160.55 b	23.33 d	26 .00 e	811.50 c	844.23 c	69.00 e	68.33 e	90.66 f	89.00 f	16.81 ab	15.96 bc
	Giza 102	**100%**	141.00cde	142.55 cd	26.00 bc	27.66 cd	826.26 c	841.11 c	61.00 h	60.33 h	80.66 h	79.00 h	8.26 g	8.83 i
		75%	138.33 c-f	142.88 cd	25.66 bc	27.33 d	818.73 c	842.11 c	58.00 j	57.33 j	75.66 l	74.00 l	9.12 g	10.26 ghi
		50%	100.33 h	103.44 fg	23.33 d	25.00 f	734.13 f	745.65 f	54.00 l	54.06 l	69.66 o	68.00 o	14.53 b-e	13.68 de
May, 30	**Sakha 53**	**100%**	182.66 a	180.33 a	26.00 bc	28.33 bc	858.03 b	868.47 b	76.00 b	75.33 b	99.66 b	98.00 b	13.96 c-f	12.82 ef
		75%	184.66 a	185.22 a	25.33 c	28.33 bc	853.63 b	876.22 b	70.00 d	69.33 d	76.66 k	75.00 k	15.67 a-d	14.25 c-f
		50%	130.66 f	135.33 d	21.33 fg	23.66 g	746.50 ef	770.14 e	62.00 g	61.33 g	81.66 g	80.00 g	15.96 a-d	15.39 b-e
	Giza 102	**100%**	136.66 def	139.00 cd	23.66 d	26.33 e	784.93 d	803.86 d	60.00 i	59.33 i	77.66 j	76.00 j	12.25 efg	11.4 fgh
		75%	134.66 ef	136.44 cd	23.00 de	25.00 f	771.86 d	792.47 d	57.00 k	56.33 k	75.66 l	74.00 l	15.67bcd	12.25 efg
		50%	86.66 i	89.66 h	20.33 fg	22.66 h	674.73 h	695.83gh	54.00 l	53.33 m	72.66 m	71.00 m	18.24 a	17.95 ab
June, 30	**Sakha 53**	**100%**	146.00 bc	143.22 cd	23.00 de	24.66 f	755.56 e	761.04 ef	75.00 c	74.33 c	96.66 c	95.00 c	13.68 def	13.68 def
		75%	143.66 bcd	147.55 c	21.66 ef	25.00 f	741.23 ef	761.72 ef	68.00 f	67.33 f	92.66 e	91.00 e	16.53abc	15.67 a-d
		50%	104.00 h	110.11 ef	17.33 h	20.00 i	651.23 i	674.45 i	61.00 h	60.33 h	79.66 i	78.00 i	17.95 a	16.81abc
	Giza 102	**100%**	116.33 g	118.88 e	21.33 fg	23.33 gh	694.50 g	712.25 g	58.00 j	57.33 j	76.66 k	75.00 k	12.82 ef	13.68 de
		75%	112.66 g	114.77 e	20.00 g	23.00 gh	664.80 hi	683.34 hi	57.00 k	56.33 k	75.66 l	74.00 l	15.67bcd	14.25cde
		50%	90.66 i	94.66 gh	17.33 h	19.66 i	598.46 j	628.98 j	53.00 m	52.33 n	70.66 n	69.00 n	18.52 a	16.81abc

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

Table 5. Effect of sowing dates and IR on yield, yield components and Water use efficiency of two sunflower cultivars at 2018 and 2019 seasons

Treatment			Head diameter (cm)		Seed number/ plant		Seed weight/ plant (g)		100-seed weight (g)		Seed yield (kg/fed.)		Water use efficiency (kg/m^3)	
			2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
1. Effect of the sowing dates														
April, 30			22.77 a	23.21 a	1202.99 a	1119.44 a	76.77 a	76.52 a	6.27 a	6.77 a	1471.38a	1466.72a	0.61 a	0.62 a
May, 30			19.52 b	20.56 b	990.96 b	914.09 b	53.26 b	54.79 b	5.30 b	5.95 b	1020.83b	1050.28b	0.44 b	0.45 b
June, 30			16.50 c	16.92 c	790.38 c	767.02 c	38.56 c	37.90 c	4.38c	4.87 c	739.14 c	726.47 c	0.34 c	0.34 c
2. Effect of sunflower cultivars														
Sakha 53			20.14 a	20.72 a	981.74 b	933.45 a	61.01 a	60.96 a	5.78 a	6.34 a	1169.41a	1168.52a	0.50 a	0.50 a
Giza 102			19.05 b	19.74 b	1007.81 a	933.58 a	51.38 b	51.85 b	4.85 b	5.38 b	984.82 b	993.79 b	0.42 b	0.42 b
3. Effect of irrigation														
100% (control)			23.72 a	23.94 a	1130.55 a	1028.99 a	70.33 a	68.81 a	6.15 a	6.61 a	1348.01a	1318.97a	0.44 b	0.43 c
75%			22.47 b	23.12 b	1094.08 b	1039.07 a	62.34 b	62.97 b	5.40 b	5.95 b	1194.90b	1207.04b	0.51 a	0.52 a
50%			12.61 c	13.64 c	759.70 c	732.49 b	35.92 c	37.43 c	4.40 c	5.03 c	688.44 c	717.46 c	0.44 b	0.46 b
4. Interaction effect among sowing dates and irrigation treatments on the two sunflower cultivars														
April, 30	**Sakha 53**	**100%**	28.66 a	28.40 a	1359.73 a	1246.00ab	103.05 a	99.07 a	7.57 a	7.97 a	1975.05a	1898.90a	0.61 cd	0.61 cd
		75%	26.66 b	27.06 b	1341.26 a	1240.72ab	95.21 b	93.93 b	7.09 b	7.59 a	1824.85b	1800.34b	0.75 a	0.75 a
		50%	15.33 h	17.06 h	918.01 g	872.03 e	53.17 f	57.89 e	5.79 e	6.69 bcd	1019.05 f	1109.56e	0.63 bc	0.63 bc
	Giza 102	**100%**	26.33 b	26.18 b	1273.51 b	1189.13 b	83.13 c	82.18 c	6.53 c	6.93 bc	1593.33c	1575.16c	0.51 e	0.51 e
		75%	25.33 b	25.18 c	1354.83 a	1280.99 a	81.11 c	80.43 c	5.98 e	6.29 de	1554.68c	1541.52c	0.66 b	0.66 b
		50%	14.33 hi	15.402 i	970.63 f	887.79 e	44.94 g	45.64 g	4.63 f	5.16 fg	861.31 g	874.86 g	0.55 e	0.55 e
May, 30	**Sakha 53**	**100%**	23.33 c	24.18 d	1040.63 e	976.38 cd	67.43 d	68.98 d	6.48 cd	7.09 b	1292.35d	1322.17d	0.45 f	0.45 f
		75%	23.00 cd	24.62 cd	1095 cd	1008.42 c	62.20 de	65.47 d	5.68 e	6.51 cd	1192.18de	1254.90d	0.56 de	0.56 de
		50%	13.33 ij	14.40 j	763.30 j	707.75 h	37.55 h	38.92 h	4.90 f	5.52 f	719.74 h	746.06 h	0.50 e	0.50 e
	Giza 102	**100%**	23.33 c	24.18 d	1086.53de	1002.70 c	65.68 d	65.46 d	6.04 de	6.55 cd	1258.81 d	1254.75d	0.38 gh	0.38 gh
		75%	21.83 de	22.62 e	1097.33cd	990.73 cd	52.78 f	54.18 ef	4.80 f	5.50 f	1011.64 f	1038.58ef	0.41f g	0.41f g
		50%	12.33 j	13.40 k	862.966 hi	798.53 fg	33.93 h	35.75 h	3.93 g	4.50 h	650.29 h	685.22 h	0.40 gh	0.40 gh
June, 30	**Sakha 53**	**100%**	20.66 ef	20.23 f	879.23 gh	860.03 ef	56.99 ef	51.74 f	5.74 e	6.04 e	1092.39ef	991.75 f	0.35 hij	0.35 hij
		75%	19.66 fg	19.95 fg	859.96 hi	924.06 de	46.60 g	46.95 g	4.72 f	5.10 fg	893.19 g	899.88 g	0.38 ghi	0.38 ghi
		50%	10.66 k	10.62 l	578.60 k	565.63 i	26.92 i	25.72 i	4.03 g	4.59 h	515.94 i	493.11 i	0.33 ij	0.33 ij
	Giza 102	**100%**	20.00 f	20.51 f	1143.70 c	899.67 e	45.71 g	45.45 g	4.57 f	5.08 fg	876.13 g	871.11 g	0.30 j	0.30 j
		75%	18.33 g	19.29 g	816.10 i	789.51 g	36.15 h	36.88 h	4.10 g	4.70 gh	692.84 h	707.01 h	0.32 j	0.32 j
		50%	9.66 k	10.95 l	464.73 l	563.19 i	19.01 j	20.65 j	3.10 h	3.71 i	364.34 j	395.94 j	0.25 k	0.25 k

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

Conclusion

Sakha-53 is very suitable for growing under North Sinai than Giza-102. Also, increasing air temperatures degree from April to September resulted in more leaves proline content and less growth stages, yield, and yield components, but improved other studied traits. Full irrigation requirement treatment (100% IR) was achieving higher economical seed yields.

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الملخص العربي

استجابة صنفان من دوار الشمس لمواعيد الزراعة ومعاملات الرى تحت ظروف شمال سيناء

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أجريت هذه الدراسة لمعرفة تأثير مواعيد الزراعة (٣٠ أبريل، ٣٠ مايو، ٣٠ يونية) واحتياجات الري (٥٠%، ٧٥%، ١٠٠%) على نمو ومكونات محصول صنفين من أصناف دوار الشمس (سخا ٥٣، جيزة ١٠٢) والتفاعل بينهم تحت ظروف شمال سيناء، أظهرت النتائج أن زراعة دوار الشمس في الميعاد المبكر (٣٠ أبريل) أدى الى زيادة ملحوظة في النمو الخضري، والمحصول ومكوناته، وكفاءة استخدام المياه. بينما ادى ميعاد الزراعة المتأخرة (٣٠ يونية) إلى الحصول على أعلى محتوى للبرولين بالأوراق. في حين أدى ري نباتات دوار الشمس باستخدام ٧٥% و٥٠% من الاحتياجات المائية الى تأثر النباتات بإجهاد مائي ما بين متوسط الى شديد. من ناحية أخرى، سجل نبات دوار الشمس صنف سخا ٥٣ أعلى نموًا خضريًا ومحصولاً بيولوجياً مقارنة بصنف جيزة ١٠٢. وفيما يتعلق بتأثير التفاعل بين مواعيد الزراعة ومعاملات الاحتياجات المائية وأصناف دوار الشمس، فقد أشارت النتائج إلى أن زراعة صنف سخا ٥٣ في نهاية أبريل والري بمعدل ١٠٠% من الإحتياجات المائية يعطي أعلى معدل لنمو النبات وأكبر كمية من محصول البذور يليه زراعة صنف سخا ٥٣ في نهاية أبريل والري بمعدل ٧٥% من الإحتياجات المائية.

الكلمات الإسترشادية: دوار الشمس، مواعيد الزراعة، الاحتياجات المائية، سخا ٥٣، جيزة ١٠٢.

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