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RESPONSE OF SOME SUNFLOWER GENOTYPES TO NITROGEN FERTILIZER LEVELS

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ABSTRACT
A field study was carried out during summer seasons of 2018 and 2019 at the Experimental Farm of Faculty of Environmental Agricultural Sciences, Arish University, El-Arish, North Sinai Governorate. Egypt, This study aimed to investigate the response of three sunflower genotypes (*Helianthus annus* L., *i.e.* Giza-102, Sakha-53, Line 120 to three nitrogen levels N1=15, N2= 30, N3= 45 kg N fed^{-1}to maximize seed and oil yields of sunflower crop under the newly reclaimed soil and the environmental conditions of North Sinai. Salinity of irrigation water ranged from 4500 to 5500 ppm, using drip irrigation system. The main results were that Giza-102 genotype surpassed the other studied genotypes in plant height (cm), stem diameter (cm),number of leaves per plant, leaves fresh and dry weights per plant(g), yield attributes, seed and oil yields. There were significant differences between N-fertilizer levels found at most of growth characters, seed and oil yields per feddan. While, oil content decreased.

INTRODUCTION

Sunflower (*Helianthus annuus*, L.) plays an important role in solving the gap between demand and consumption of edible oil in Egypt, where, seeds contain about 40 -45% oil, it can grow under wide environmental conditions and its roughage could be used in animal feeding. Sunflower ranked the fourth position after groundnut, soybean and rapeseed (**Khandekar *et al.*, 2018**). It belongs to Asteraceae (compositeae) family and originated from the South western United States and Northern Canada (**Mohamed *et al.*, 2018**).Nitrogen (N) is the most significant nutrient for improving seed and oil yields, as it is the most essential mineral nutrient and the widest application in modern agriculture (**Mulvaney *et al.*, 2009**). Application N fertilizer levels at 45 kg N fad.$^{-1}$ (**Hassan, 2010**) in Egypt; 120 kg N ha^{-1} (**Oyinlola *et al.*, 2010**) in Nigerian; 125 kg N ha^{-1} in Pakistan, resulted taller plants and thicker stems as compared to the lower and/or upper N used levels. The increase in seed yield and its components of sunflower as the amount of nitrogen fertilizer increased may refer to enhancing vegetative growth of aerial parts and physical maturity. Maximum oil content (41.9%) was resulted from without application of N fertilizer and minimum oil content (38.4%) was observed when 240 kg N ha^{-1} was applied **(Nasim *et al.*, 2012).** Also, **El-Sarag (2007)** found that N application improved growth and growth analyses of sunflower cultivars

MATERIALS AND METHODS

A field study was carried out during summer seasons of 2018 and 2019 at the Experimental Farm, Faculty of Environmental Agricultural Sciences, Arish University, El-Arish, North Sinai Governorate, Egypt. This study aimed to investigate the response

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of three sunflower genotypes (*Helianthus annus* L., *i.e.* Giza-102, Sakha-53, Line 120 to three nitrogen levels (N1= 15, N2= 30, N3= 45 kg N fad.$^{-1}$). Sunflower seeds were obtained from Oil Crops Research Section, Field Crops Research Institute, Agriculture Research Center, Giza, Egypt. Factorial experiment split plot design with four replications was used and included 9 treatments which were the combination of three cultivars in the main plots and the three nitrogen fertilizer levels in the sub-plots. Ammonium nitrate fertilizer (33.5% N) was the source of nitrogen in both seasons. The fertilizer quantities were divided into 8 equal portions, the first one was added after 2 weeks from sowing then the other portions were added gradually every week. The recommended rate of calcium superphosphate (15.5% kg P_2O_5) was applied during soil preparation at the rate of 200 kg fad.$^{-1}$ Potassium sulfates (48% kg K_2O) at rate of 50 kg fed^{-1} was applied at five equal doses, the first dose after thinning and the other doses every one week. All other agricultural practices were carried out as recommended for sunflower growing under the conditions of North Sinai. Drip irrigation system was used with water salinity of 4500 - 5500 ppm. The irrigation lines length was 30 m and between lines 50 cm was left to gain plot area of 10.5 m^2 (3.5 m long x 3 m wide, which gave approximately 84 plants/ plot with 25 cm between drippers).The planting date was on 23th May in 2018 and 2019 seasons. The harvesting dates for the three genotypes Giza-102, Sakha-53, Line- 120 were after 73, 83 and 85 days, respectively. Soil texture was sandy and total N were 10 and 13 ppm with pH average 7.6 according to the soil mechanical analysis in both seasons. Samples of five guarded plants from each experimental plot were collected randomly at 30, 40, 50 and 60 days after sowing for studying the effects of the applied treatments on vegetative characters (plant height, stem diameter, number of leaves/plant, fresh and dry weights for leaves, No. head per plant).At the end of heading, the heads of the three inner rows were bagged at early seed development for avoiding bird damages and were used for estimating yield and its components as well as seed oil content. Ten guarded plants were taken randomly from each experimental plot for measuring head diameter (cm), 100- seed weight (g), seed weight per plant (g),seed yield per m^{-2} then seed yield (ton fad.$^{-1}$) was calculated. Seed oil content (%) was determined by using Soxhlet method with 6-syphones according to the **AOAC (1990).** Data were statistically analyzed according to **Snedecor and Cochran (1956**) using MSTAT computer program V.4 (1986). The means values were compared at 0.05 level of probability using Duncan's Multiple Range Test (**Duncan, 1955**).

RESULTS AND DISCUSSION

Results in Tables 1, 2, 3, 4, 5 and 6 show the response of sunflower genotypes (Sakha-53, Line 120, Giza-102) to nitrogen fertilizer levels (15, 30and 45 kg N fad.$^{-1}$) and their interactions at different growth periods (after 30, 40, 50 and 60 days after sowing DAS and seed yield, yield components and seed oil contents in two summer seasons (2018, 2019).

Plant Height (cm)

Genotypes variation

There are significant differences among sunflower genotypes regarding plant height, stem diameter, number of leaves per plant, leaves fresh weight (g) and Leaves dry weight (g) at most of samples in both seasons (Table 1). Giza-102 gave the highest value of plant height (61.85, 83.91, 129.00 and 174.50 cm) in the first seasons, the same trend was recorded in the second season where in the highest value of plant height recoded 80.50, 90.13, 103.20 and 179.70 cm at 30, 40, 50 and 60 days, respectively.

Table 1. Effect of genotypes and nitrogen levels on plant height (cm) of sunflower at 30, 40, 50 and 60 days after sowing in 2018 and 2019 seasons

Vegetative characters	Treatment	Plant height (cm) 2018				Plant height (cm) 2019			
	Days	30	40	50	60	30	40	50	60
Genotype	Sakha-53	52.17ab	79.21ab	113.90b	170.10b	71.00c	82.74b	93.87c	167.90c
	Line-120	49.95c	78.57b	117.80ab	171.20ab	75.57b	85.06ab	96.43b	172.50b
	Giza-102	61.85a	83.91a	129.00a	174.50a	80.50a	90.13a	103.20a	179.70a
Nitrogen level	15 N	57.42 b	78.31b	98.90b	116.90 b	63.48 c	83.46 b	93.87 c	166.30 b
	30 N	58.33 ab	80.81b	102.50ab	136.00ab	71.94 b	84.50 ab	96.43 b	173.20 ab
	45 N	59.83 a	84.57a	119.20a	174.80 a	77.65 a	86.96 a	103.20 a	178.60 a

Means having the same letter within each column are not significantly differed at 0.05 level, according to Duncan′s multiple range test.

Effect of nitrogen levels

There are significant effects of nitrogen levels on plant height at all growth stages studied of sunflower in both seasons (Table 1). The tallest plants (59.83, 84.57, 119.20 and 174.80 cm) in the first seasons, and (77.65, 86.96, 103.20 and 178.60 cm) in the $_2^{nd}$ season at 30, 40, 50 and 60 days, respectively, were obtained under nitrogen level of 45kg fad.

Effect of interaction

Results in Table 2 show significant effect of genotypes × nitrogen levels interaction on plant height at 30, 40, 50 and 60 days in 2018 and 2019 seasons where in the tallest plants recorded 77.17, 96.50, 141.70 and 183.00 cm in the first seasons; and 88.00,106.33,122.30 and 184.60 in the $_2^{nd}$ season. The same results were by with **Awad and Gharib (2009), Abd El-Motagally and Osman (2010), Oyinloa *et al*. (2010), Irika (2015), Ravishankar and Malligawad (2017) and Khandekar *et al*. (2018).** They placed that application of various nitrogen mineral fertilizer levels was followed by a significant increase in plant height (cm).

Stem Diameter (cm)

Genotypes variation

There are significant differences among sunflower genotypes in stem diameter (cm) at most of samples in both seasons (Table 3). Sunflower cultivar Giza-102 gave the highest value for stem diameter (1.356, 1.551, 1.732 and 1.891 cm) in the first seasons, the same trend was recorded in the second season and the values were 1.500, 1.600, 1.774 and 1.956 cm at 30, 40, 50 and 60 days, respectively.

Effect of nitrogen levels

There are significant effects of nitrogen levels on stem diameter at all growth stages studied of sunflower in both seasons (Table 3). The heights values of stem diameter in the first seasons (1.344, 1.537, 1.659 and 1.833 cm) in the second seasons and (1.467, 1.556, 1.811 and 1.930 cm) in the second seasons at 30, 40, 50 and 60 DAS, respectively were the resultant of nitrogen treatment 45kg/fad.

Effect of interaction

Results in Table 4 show significant effect of genotypes × nitrogen levels interaction on

Table 2. Effect of interaction among genotypes and nitrogen levels on plant height (cm) of sunflower at 30, 40, 50 and 60 days after sowing in 2018 and 2019 seasons

Genotype	Nitrogen levels	Plant height (cm) 2018				Plant height (cm) 2019			
Days		30	40	50	60	30	40	50	60
Sakha-53	15 N	39.33hi	70.50cd	106.00k-o	162.50kl	67.00lmn	72.17kl	85.33jkl	161.40jkl
	30 N	48.33e-i	72.50bcd	95.67no	170.50e-i	71.67h-l	79.00g-j	95.50f-i	171.50fgh
	45 N	53.33d-h	77.33a-d	116.30f-l	173.20def	75.67d-j	81.83e-h	98.83e-i	174.00def
Line-120	15 N	47.50f-i	80.00a-d	112.20j-m	174.30cde	76.50d-i	82.33e-h	96.33f-i	171.20fgh
	30 N	57.67b-g	84.17a-d	116.00g-l	175.50b-e	77.00c-i	85.00d-h	104.80c-f	177.80bcd
	45 N	69.00abc	88.83abc	133.20a-e	178.50abc	83.00abc	88.67cde	109.70bcd	179.50bc
Giza-102	15 N	60.83b-g	88.83abc	129.70b-h	175.50b-e	78.67c-g	85.00d-h	102.00d-h	171.10fgh
	30 N	62.33b-e	94.00ab	134.00a-d	180.30ab	81.33b-e	88.33cde	114.20ab	180.80b
	45 N	77.17a	96.50 a	141.70a	183.00a	88.00a	106.33 a	122.30a	184.40a

Means having the same letter within each column are not significantly differed at 0.05 level, according to Duncan′s multiple range test.

Table 3. Effect of genotypes and nitrogen levels on stem diameter (cm) of sunflower at 30, 40, 50 and 60 days after sowing in 2018 and 2019 seasons

Vegetative characters	Treatment	stem diameter (cm) 2018				stem diameter (cm) 2019			
Days		30	40	50	60	30	40	50	60
Genotype	Sakha-53	1.211c	1.48c	1.62c	1.76c	1.330c	1.459c	1.644c	1.844c
	Line-120	1.296b	1.49b	1.65b	1.82ab	1.374b	1.481b	1.659b	1.890b
	Giza-102	1.356a	1.551a	1.732a	1.891a	1.500a	1.600a	1.774	1.956a
Nitrogen level	15 N	1.265c	1.504c	1.610c	1.737c	1.341c	1.433c	1.722c	1.874c
	30 N	1.310ab	1.515ab	1.620b	1.800b	1.396b	1.463b	1.796b	1.885b
	45 N	1.344a	1.537a	1.659a	1.833a	1.467a	1.556a	1.811a	1.930a

Means having the same letter within each column are not significantly differed at 0.05 level, according to Duncan′s multiple range test.

Table 4. Effect of interaction between genotypes and nitrogen levels on stem diameter (cm) of sunflower at 30, 40, 50 and 60 days after sowing in 2018 and 2019 seasons

Genotype	Nitrogen level	Stem diameter(cm) 2018				Stem diameter(cm)2019			
Days		30	40	50	60	30	40	50	60
Sakha-53	15 N	1.117fg	1.47cde	1.63b-f	1.70def	1.233e-h	1.300ij	1.567hij	1.800fg
	30 N	1.100g	1.40ef	1.57def	1.70def	1.167fgh	1.367g-j	1.633f-i	1.867d-g
	45 N	1.167d-g	1.43def	1.57def	1.73def	1.400b-e	1.567b-e	1.700d-g	1.900c-f
Line-120	15 N	1.317b-e	1.43def	1.60c-f	1.70def	1.333c-f	1.467d-h	1.600g-j	1.900c-f
	30 N	1.450abc	1.53bcd	1.83ab	1.90bcd	1.400b-e	1.500d-g	1.667e-h	1.900c-f
	45 N	1.483ab	1.60ab	1.80abc	1.90bc	1.467bcd	1.600a-d	1.667e-h	1.933b-e
Giza-102	15 N	1.233d-g	1.50b-e	1.63b-f	1.90bcd	1.367cde	1.500d-g	1.667e-h	1.933b-e
	30 N	1.317b-e	1.53bcd	1.70a-f	1.90bcd	1.500bc	1.600a-d	1.800a-d	2.00bc
	45 N	1.567a	1.670a	1.900a	2.130a	1.700a	1.733a	1.900a	2.133a

Means having the same letter within each column are not significantly differed at 0.05 level, according to Duncan′s multiple range test.

the stem diameter at 30, 40, 50 and 60 DAs in 2018 and 2019 seasons. The largest stem diameter (1.567, 1.670, 1.900 and 2.130 cm) in the first seasons, in the second seasons gave and (1.700, 1.733, 1.900and 2.133 cm) in the second on at 30, 40, 50 and 60 DAS after sowing, respectively, were recorded under the interaction treatment included sowing sunflower cultivar Giza-102 and application level was followed by a significant increase in stem diameter (cm) in both seasons.

Genotypes Variation

Number of leaves per plant

There are significant differences among sunflower genotypes at most of samples in both seasons Table 5. Giza-102 gave the highest value for each of number of leaves per plant (15.04, 17.70, 19.89 and 22.98) in the first seasons, the same trend was recorded in the second season gave the highest value for each of number of leaves per plant (16.28, 19.24, 21.81 and 25.35) at 30, 40, 50 and 60 days, respectively.

Effect of nitrogen levels

There are significant effects of nitrogen levels on number of leaves/plant at all growth stages studied of sunflower in both seasons (Table 5). Application of the highest N level (45 kg N/fad.) produced the largest number of leaves per plant (13.63, 17.50, 20.19 and 23.43) in the first seasons and 15.26, 19.37, 21.69 and 24.83 at 30, 40, 50 and 60 DAS, respectively.

Effect of interaction

Results in Table 6 show significant effect of genotypes x nitrogen levels interaction on number of leaves/plant at 30, 40, 50 and 60 DAS in 2018 and 2019 seasons. The largest number of leaves per plant 19.67, 21.17, 21.83 and 26.17 in the first seasons, 18.50, 21.17, 23.17 and 27.33 at 30, 40, 50 and 60 DAS after respectively were recorded under the impact of sowing Giza-102 cultivar and supplying 45kg N/fad.

The same results were found by **Hassan (2010), Oyinlola *et al.* (2010)**, **Hama (2015)**, **Irika (2015) and Kandil *et al.* (2017)**. The opposite trend was observed by **Abaza (2010)**.

Leaves Fresh Weight

Genotypes variation

There are significant differences among sunflower genotypes in their leaves fresh weight at most of samples in both seasons (Table 7). Giza-102 gave the highest leaves fresh weight (78.55, 95.34, 110.83 and 133.17g.) in the first seasons, the same trend was recorded in the second season, wherein the highest values of leaves fresh weight were 92.20, 105.17, 117.18 and 137.47g at 30, 40, 50 and 60 DAS, respectively.

Effect of nitrogen levels

There are significant effects of nitrogen levels on leaves fresh weight at all growth stages studied of sunflower in both seasons (Table 7). The heights values of leaves fresh weight (93.87, 117.30, 135.14 and 159.14) in the first seasons, as well as 109.33, 135.65, 147.13 and 180.41) at 30, 40, 50 and 60 DAS, respectively were the resulted of adding 45kg N/fad.

Effect of interaction

Results in Table 8 show significant effect of genotypes x nitrogen levels on interaction leaves fresh weight at 30, 40, 50 and 60 DAS in 2018 and 2019 seasons. The largest leaves fresh weight (123.36, 148.32, 189.13 and 206.23g) in the first seasons, as well as (135.47, 175.27, 205.11 and 240.16g) in the $_2$nd season at 30, 40, 50 and 60 days after sowing, respectively. The same results were found by **Hassan (2010)**. They found adding nitrogento mineral fertilizers level was followed by a significant increase in leaves fresh weight in.

Leaves Dry Weight

Genotypes variation

There are significant differences among sunflower genotypes at most of samples in both seasons (Table 9). Giza-102 sunflower

Table 5. Effect of genotypes and nitrogen levels on number of leaves/plant of sunflower at 30, 40, 50 and 60 days after sowing in 2018 and 2019 seasons

Vegetative characters	Treatment	Number of leaves/ plant 2018				Number of leaves/ plant 2019			
Days		30	40	50	60	30	40	50	60
Genotype	Sakha-53	12.72c	15.59c	19.17bc	21.76c	14.41b	18.46b	21.00b	23.17b
	Line-120	13.09b	16.78b	19.33b	22.43b	15.26b	18.91b	21.31b	24.00ab
	Giza-102	15.04a	17.70a	19.89a	22.98a	16.28a	19.24a	21.81a	25.35a
Nitrogen level	15 N	13.23b	16.09b	19.20	21.78b	14.81b	18.30b	20.63b	22.41b
	30 N	13.35b	16.48b	19.00	21.96b	15.87b	18.94b	21.81b	25.28ab
	45 N	13.63a	17.50a	20.19b	23.43a	15.26a	19.37a	21.69a	24.83a

Means having the same letter within each column are not significantly differed at 0.05 level, according to Duncan′s multiple range test.

Table 6. Effect of interaction between genotypes and nitrogen levels on number of leaves plant of sunflower at 30, 40, 50 and 60 days after sowing in 2018 and 2019 seasons

Genotype	Nitrogen level	Number of leaves /plant 2018				Number of leaves/ plant 2019			
Days		30	40	50	60	30	40	50	60
Sakha-53	15 N	15.00cd	17.00hi	18.83e-h	20.83g-j	12.83kl	17.00hi	19.50kl	21.33kl
	30 N	15.83bcd	18.00d-h	19.17d-h	22.33d-h	13.83ijk	19.00d-h	21.00f-j	23.00hij
	45 N	16.67a-d	18.00abc	19.50def	22.50d-g	14.33h-k	20.00a-e	22.17b-f	23.67c-g
Line-120	15 N	17.33abc	18.50e-h	18.83e-h	22.83c-g	14.17h-k	18.50e-h	21.00f-j	23.83e-i
	30 N	18.00abc	19.17c-g	21.17abc	24.67abc	15.83d-h	19.17c-g	22.00b-f	24.83b-f
	45 N	18.33ab	20.50a-e	20.98a-d	25.33ab	16.33c-g	20.50a-e	22.83a-d	26.17abc
Giza-102	15 N	17.67abc	18.83d-h	20.00b-e	22.67d-g	15.67d-h	18.83d-h	21.50e-h	24.17b-f
	30 N	18.00abc	20.17a-e	20.50a-d	23.50cde	15.83d-h	20.17a-e	22.00b-f	25.17ab
	45 N	19.67a	21.17a	21.83a	26.17a	18.50a	21.17abc	23.17a	27.33a

Means having the same letter within each column are not significantly differed at 0.05 level, according to Duncan′s multiple range test.

Table 7. Effect of genotypes and nitrogen levels on leaves fresh weight (g) of sunflower at 30, 40, 50 and 60 days after sowing in 2018 and 2019 seasons

Vegetative characters	Treatment	Leaves fresh weight (g) 2018				Leaves fresh weight (g) 2019			
Days		30	40	50	60	30	40	50	60
Genotype	Sakha-53	63.42 b	73.55 b	85.73 b	103.17 b	71.99 b	85.93 b	95.13 b	113.30 b
	Line-120	57.12 c	65.87 c	77.42 c	88.22 c	67.85 c	76.47 c	87.26 c	97.22 c
	Giza-102	78.55 a	95.34 a	110.83 a	133.17 a	92.20 a	105.17 a	117.18 a	137.47 a
Nitrogen level	15 N	45.96 c	55.72 c	67.92 c	77.42 c	57.43 c	65.87 c	75.97 c	87.62 c
	30 N	65.72 b	79.96 b	97.61 b	113.68 b	83.37 b	93.45 b	102.8 b	115.37 b
	45 N	93.87 a	117.30 a	135.14 a	159.14 a	109.33 a	135.65 a	147.13 a	180.41 a

Means having the same letter within each column are not significantly differed at 0.05 level, according to Duncan′s multiple range test.

Table 8. Effect of interaction between genotypes and nitrogen levels on leaves fresh weight (g) of sunflower at 30, 40, 50 and 60 days after sowing in 2018 and 2019 seasons

Genotype	Nitrogen level	Leaves fresh weight(g) 2018				Leaves fresh weight (g)2019			
Days		30	40	50	60	30	40	50	60
Sakha-53	15 N	80.47 e	84.18 f	98.51	114.32g	82.90 f	100.03 f	110.52g	124.4 g
	30 N	90.72 c	105.15 d	116.1	133.5 f	97.29 d	113.72e	125.30 e	145.16 e
	45 N	102.16 b	125.43 b	14530	190.07 b	118.23b	155.16 b	179.53b	218.99 b
Line-120	15 N	75.63e	81.13f	74.32	111.17g	77.53f	96.83f	106.33g	121.43g
	30 N	84.72c	100.11d	112.16	130.17f	94.31d	107.22e	120.17e	140.13.e
	45 N	96.83b	125.43b	140.58	185.43b	113.26b	150.47b	175.73b	215.17b
Giza-102	15 N	82.71 d	107.5 d	129.16	153.9 d	105.12 c	127.41d	145.18 d	160.40 d
	30 N	99.27 b	122.11c	150.40	175.98 c	115.23b	145.07 c	165.43 c	183.41 c
	45 N	123.36 a	148.32 a	189.13a	206.23 a	135.47 a	175.27 a	205.11 a	240.16 a

Means having the same letter within each column are not significantly differed at 0.05 level, according to Duncan′s multiple range test.

Table 9. Effect of genotypes and nitrogen levels on leaves dry weight (g) of sunflower at 30, 40, 50 and 60 days after sowing in 2018 and 2019 seasons

Vegetative characters	Treatment	Leaves dry weigh(g) 2018				Leaves dry weight(g) 2019			
Days		30	40	50	60	30	40	50	60
Genotype	Sakha-53	22.63 b	28.16 b	32.52 b	34.09 b	30.18 b	31.17 b	34.96 b	43.15 b
	Line-120	20.75 c	24.45 c	28.17 c	31.27 c	26.47 c	29.43 c	33.84 c	39.34 c
	Giza-102	22.80 a	30.14 a	35.08 a	42.19 a	31.36 a	32.45 a	40.16 a	46.62 a
Nitrogen level	15 N	17.32 c	25.99 c	28.50 c	30.29 c	27.92 c	29.71 c	31.05 c	34.06 c
	30 N	24.71 b	26.59 b	33.17 b	36.20 b	31.56 b	32.18 b	35.98 b	43.63 b
	45 N	19.63 a	33.41 a	38.04 a	44.84 a	34.16 a	35.96 a	46.11a	55.46 a

Means having the same letter within each column are not significantly differed at 0.05 level, according to Duncan′s multiple range test.

cultivar gave the highest value of leaves dry weight (22.80, 30.14, 35.08 and 42.19g) in the first seasons, the same trend was recorded in the second season leaves dry weight valued as much as (31.36, 32.45, 40.16 and 46.62g) at 30, 40, 50 and 60 DAS, respectively.

Effect of nitrogen levels

There are significant effects of nitrogen levels on leaves dry weight(g) at all growth stages studied of sunflower in both seasons (Table 9). The heights values of leaves dry weight (19.63, 33.41, 38.04 and 44.84) in the first seasons, as well as 34.16, 35.96, 46.11 and 55.46) in the second seasons at 30, 40, 50 and 60 DAS, respectively.

Effect of interaction

Results in Table 10 show significant effect of genotypes x nitrogen levels interaction on leaves dry weight (g) at 30, 40, 50 and 60 DAS in 2018 and 2019 seasons. The largest leaves dry weight (35.74, 37.25, 44.20 and 55.87) in the first seasons, as well as in the second seasons (39.74, 42.54, 56.18 and 65.23) at 30, 40, 50 and 60 DAS, respectively were obtained

Table10. Effect of interaction between genotypes and nitrogen levels on leaves dry weight (g) of sunflower at 30, 40, 50 and 60 days after sowing in 2018 and 2019 seasons

Genotype	Nitrogen level	Leaves dry weight (g)2018				Leaves dry weight (g) 2019			
Days		30	40	50	60	30	40	50	60
Sakha-53	15 N	26.14 e	30.93 ef	35.91 f	35.28 gh	32.19	33.26 f	37.19 g	50.61c
	30 N	30.80 c	32.47d	36.15 e	42.64 cd	33.81	35.15 e	39.65 f	54.45 b
	45 N	32.73 b	35.14 b	42.12 b	50.13 b	37.60	40.29 b	50.68 b	65.20 a
Line-120	15 N	22.18 e	26.54ef	32.41e	38.29cd	29.89	30.93f	33.15g	45.63c
	30 N	25.34 c	28.14d	37.53b	45.31b	30.74	31.18e	36.46f	50.19b
	45 N	27.13b	31.52b	24.13 l	21.09 l	32.24	35.62b	45.11b	60.71a
Giza-102	15 N	26.75 d	31.12 e	37.05 d	43.65 c	33.01	34.44 d	45.17 d	50.16 c
	30 N	30.19 c	33.45 c	38.79 c	47.93 b	35.28	35.97 c	46.34 c	52.10 b
	45 N	35.74 a	37.25 a	44.20 a	55.87 a	39.74a	42.54 a	56.18 a	65.23 a

Means having the same letter within each column are not significantly differed at 0.05 level, according to Duncan′s multiple range test.

under the interaction effect of sunflower Giza-102- and N fertilizer level 45kg/fad. The same results were found by **Awad and Gharib (2009), Abd El-Motagally and Osman (2010), Hassan (2010), Ravishankar and Malligawad (2017) and Cechin *et al.* (2018).** They reported that adding of sunflower seed production response to mineral nitrogen fertilizers level was followed by a significant increase in leaves dry weight.

Yield and Yield Components

Head diameter, 100 seed weight and seed oil content (%)

Genotypes variation

There are significant differences among sunflower genotypes head diameter, 100 seed weight and seed oil content (%) in both seasons (Table 11). Giza-102 gave the highest value for each of head diameter (cm) (16.08, 18.31), 100-seed weight (g) (5.40, 5.60) and seed oil content (%) (39.42, 42.53) in the first and second seasons, respectively.

Effect of nitrogen levels

There are significant effects of nitrogen levels on head diameter, 100 seed weight and seed oil content (%) in both seasons (Table 11). The heights values of head diameter (cm) (17.90, 18.23), 100-seed weight (g) (5.71, 6.72) and seed oil content (%) (34.45, 34.33) in the first and second season, respectively were obtained due to applying 45kgN/fad.

Effect of interaction

Results in Table 12 show significant effect of genotypes x nitrogen levels interaction on head diameter, 100 seed weight and seed oil content (%) in 2018 and 2019 seasons. There were significant effects of sunflower Genotype x nitrogen levels interaction. The tallest head diameter (cm) (21.07, 22.56), 100-seed weight (g) (7.49, 8.02) and seed oil content (%) (32.25, 33.63) in the first and second season, respectively were obtained under the interaction effect of sunflower Giza-102- and N fertilizer level 45 kg/fad. Similar studied have been reported by **El-Sarag (2007), Awad and Ghrib (2009)**, **Solimanzadeh *et al.* (2010), Mahrous *et al.* (2014), Gul and Kara (2015) and Kandil *et al.* (2017)**. Seed weight (g/plant) and seed and oil yields/fad.

Genotypes variation

There are significant differences among sunflower genotypes head diameter, 100 seed weight and seed oil content (%) in both

Table 11. Effect of genotypes and nitrogen levels on head diameter (cm), 100-seed weight (gm) and seed oil content (%) of sunflower in 2018 and 2019 seasons

Vegetative characters	Treatment	Head diameter (cm)		100-seed weight (g)		Seed oil content (%)	
		2018	2019	2018	2019	2018	2019
Genotype	Sakha-53	16.00ab	17.92ab	3.71 b	5.28 b	37.46 b	35.59 b
	Line-120	15.99b	18.15b	3.26 c	5.10 c	35.63 c	37.74 c
	Giza-102	16.08a	18.31a	5.40 a	5.60 a	39.42 a	42.53 a
Nitrogen level	15 N	14.20b	18.08b	3.45 c	4.21 c	42.49 a	43.72 a
	30 N	15.98ab	18.07b	4.50 b	5.41 b	38.38 b	39.12 b
	45 N	17.90a	18.23a	5.71 a	6.72 a	34.45 c	34.33 c

Means having the same letter within each column are not significantly differed at 0.05 level, according to Duncan′s multiple range test.

Table 12. Effect of interaction between genotypes and nitrogen levels on head diameter (cm), 100-seed weight (g) and seed oil content (%) of sunflower in 2018 and 2019 seasons

Genotype Seasons	Nitrogen level	Head diameter (cm)		100-seed weight (g)		Seed oil content (%)	
		2018	2019	2018	2019	2018	2019
Sakha-53	15 N	16.13c-f	16.87ghi	4.24 j	5.93 e	38.18ab	39.87bc
	30 N	18.00b	18.40b-f	4.54 h	6.31 d	38.18ab	39.87bc
	45 N	20.23a	19.53ab	5.45 e	7.13 b	38.18ab	39.87bc
Line-120	15 N	16.20c-f	17.33f-i	3.97j	5.71e	34.27cd	36.01ef
	30 N	17.60bc	18.00c-h	4.35h	6.18d	34.27cd	36.01ef
	45 N	18.23b	19.00abc	5.27e	7.09b	34.27cd	36.01ef
Giza-102	15 N	16.40c-f	16.80hi	6.14 c	6.24 d	32.25e	33.63g
	30 N	17.23bcd	18.67a-e	6.52 b	6.62 c	32.25e	33.63g
	45 N	21.07a	22.56a	7.49 a	8.02 a	32.25e	33.63g

Means having the same letter within each column are not significantly differed at 0.05 level, according to Duncan′s multiple range test.

seasons (Table 13). Giza-102 gave the highest value for each of seed weight/ plant (26.42, 44.75 g), seed yield (1.056, 1.790 kg/fad.), and oil yield (241.4, 394.3 kg fad.$^{-1}$) in the first and second seasons, respectively.

Effect of nitrogen levels

There are significant effects of nitrogen levels on head diameter, 100 seed weight and seed oil content (%) in both seasons (Table 13). The heights values of seed weight/plant (25.18, 48.75 g), seed yield (1.007, 1.950 kg/fad.), and oil yield (288.1, 477.2 kg fad.$^{-1}$) in the first and second season, respectively were obtained when 45kg N/fad.

Effect of interaction

Results in Table 14 show significant effect of genotypes x nitrogen levels interaction on head diameter, 100 seed weight and seed oil content (%) in 2018 and 2019 seasons. The highest on seed weight/ plant (26.97, 42.68 g), seed yield (1.078, 1.707 kg/fad.), and oil yield (0.797, 0.830kg fad.$^{-1}$) in the first and second season, were recorded due to the interaction effect of Giza-102 cultivar and N fertilizer level 45kg/fad. The same results were found by **El-Aref *et al.* (2011), Maqsood (2015) Shehzad and Maqsood (2015), Dhillon *et al.* (2017), Bagheri *et al.* (2018) and Schultz *et al.* (2018)**.

Table 13. Effect of genotypes and nitrogen levels on seed weight/plant (g), seed yield (kg/ fad.), and oil yield (kg fad.$^{-1}$) of sunflower in 2018 and 2019 seasons

Vegetative characters / Treatment		Seed weight/ plant(g)		Seed yield (kg/fad.)		Oil yield (kg fad.$^{-1}$)	
		2018	**2019**	**2018**	**2019**	**2018**	**2019**
Genotype	Sakha-53	23.27ab	39.42ab	0.930 ab	1.570 ab	158.8 b	238.3 b
	Line-120	21.97 b	35.86b	0.878 c	1.430 c	152.80 c	230.88 c
	Giza-102	26.42 a	44.75 a	1.056 a	1.790 a	241.4 a	394.3 a
Nitrogen level	**15 N**	22.07 c	38.96 c	0.882 c	1.550 c	123.7 c	179.3 c
	30 N	24.50b	41.18 b	0.980 b	1.640 b	188.7 b	292.4 b
	45 N	25.18a	48.75 a	1.007 a	1.950 a	288.1 a	477.2 a

Means having the same letter within each column are not significantly differed at 0.05 level, according to Duncan′s multiple range test.

Table14. Effect of interaction between genotypes and nitrogen levels on seed weight/ plant (g), seed yield (kg/fad.), and oil yield (kg fad.$^{-1}$) of sunflower in 2018 and 2019 seasons

Genotype	Nitrogen level	Seed weight/plant(g)		Seed yield (kg/fad.)		Oil yield (kg fad.$^{-1}$)	
		2018	**2019**	**2018**	**2019**	**2018**	**2019**
Sakha-53	15 N	20.52 g	35.44h	0.820 g	1.417 h	0.736abc	0.769abc
	30 N	22.28 f	37.11 f	0.891 f	1.484 f	0.837ab	0.876ab
	45 N	25.18 b	41.36 d	1.007 b	1.654 d	0.787ab	0.861ab
Line-120	15 N	19.96 g	34.21	0.798	1.368	0.627bcd	0.660b-e
	30 N	21.84 f	36.18	0.873	1.447	0.588b-h	0.589b-h
	45 N	24.61 b	40.61	0.984	1.624	0.567b-g	0.597b-g
Giza-102	15 N	21.16 c	36.92 c	0.846 c	1.476 c	0.554b-f	0.579b-f
	30 N	23.76 b	38.84 b	0.950 b	1.553 b	0.580b-e	0.605bcd
	45 N	26.97 a	42.68 a	1.078 a	1.707 a	0.797a	0.830a

Means having the same letter within each column are not significantly differed at 0.05 level, according to Duncan′s multiple range test.

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الملخص العربي

إستجابة بعض التراكيب الوراثية لدوار الشمس لمستويات السماد النيتروجيني

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أجريت دراسة حقلية خلال الموسم الصيفي لعامي 2018 و 2019م في المزرعة التجريبية بكلية العلوم الزراعية البيئية بالعريش جامعة العريش، محافظة شمال سيناء، مصر وذلك بهدف دراسة إستجابة بعض التراكيب الوراثية من دوار الشمس (سخا 53 وجيزة 102 وسلالة 120) لثلاث معدلات من التسميد النيتروجيني (45,30,15 كجم نيتروجين للفدان) وكان الري باستخدام نظام الري بالتنقيط وتراوحت ملوحة مياه الري بين 4500 إلى 5500 جزء في المليون وهدفت الدراسة إلى التوصل إلى أفضل معدل من التسميد النيتروجيني للسلالات المستخدمة لمعظمة إنتاج دوار الشمس من الزيت والبذور. وكانت أهم النتائج هي تفوق صنف جيزة 102 على صنف سخا 53 وسلالة 120 فى كل صفات النمو الخضري (ارتفاع النبات/سم، قطر الساق/سم، عدد أوراق النبات/نبات، الوزن الخضري والجاف للأوراق/جم)، ومساهمات المحصول ونسبة الزيت وكذلك محصول البذور، وخلصت الدراسة إلى أن التسميد النيتروجيني بمعدل (45 كجم نيتروجين للفدان أعطت أعلي قيمة لمعظم القراءات الخضرية (ارتفاع النبات/سم، قطر الساق/سم، عدد أوراق النبات/نبات، الوزن الخضري والجاف للأوراق/جم). والمحصول (قطر القرص/سم، وزن المائة بذرة/جم، النسبة المئوية للزيت، وزن بذور النبات جم، وزن بذور النبات ب كجم/ف، محصول الزيت ب كجم/ف). ولذلك لتعظيم إنتاج بذور دوار الشمس تحت ظروف المناطق شبة الجافة يمكن زراعة الصنف جيزة 102 مع معاملته بالتسميد النتروجيني 45 كجم نيتروجين للفدان.

الكلمات الإسترشادية: التراكيب الوراثية، دوار الشمس، التسميد النيتروجيني.

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