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EFFECT OF BIOFERTILIZER APPLICATION ON SOME SUNFLOWER GENOTYPES

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ABSTRACT

As there are a lot of environmental problems gaining from chemical fertilizers multiuse, more attentions has been drawn to the application of biological fertilizers in agriculture. An investigation for study the response of three sunflower genotypes (*Helianthus annus* L.) Giza-102, Sakha-53, line 120 to three bio-fertilizers (Bio1= nitrogen fixing bacteria, NFB, Bio2= phosphate dissolving bacteria, PDB, Bio3= potassium edit facilitator "PEF") 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 to maximize seed yield and oil content 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. Sunflower seeds were obtained from Oil Crops Research Section, Field Crops Research Institute, while, bio-fertilizer were obtained from Bacterilization Unite, Microbiology Soil Department, Water and Soil Research Institute, Agriculture Research Center, Giza Egypt. The main results were that Sunflower Giza-102 cultivar surpassed the other studied genotypes in plant height (cm), number of leaves per plant., fresh and dry leaves weight per plant (g)., yield attributes, head diameter (cm), 100-seed weight (g), seed oil content(%), seed weight/plant (g), seed yield (kg fed^{-1}), and oil yield(kg fed^{-1}) seed and oil yields. In concern to biofertilizers, bio3 (potassium edit facilitator) gave superiority in most traits and seed yield but Bio1 (nitrogen fixing bacteria) gave the maximum seed oil content. So, for maximizing seed yield for sunflower under semi arid regions, Giza-102 genotype can be cultivated with bio fertilizer for potassium and nitrogen fixing bacteria.

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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**). Sunflower seeds contain a high percentage of oil up to 50%, also, its meal contains high percentage of proteins, lignocelluloses fiber and minerals to use for animal feed **(Lahuf *et al.*, 2019)**. Additionally, sunflower fields are very important to honeybee breeders to produce high quality of honey, and italic, honeybees, in turn, lead to increased success pollination **(Lomascolo *et al.*, 2012**)

Available of microbial communities in the root zone promotes plant growth by

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nutrients cycling, availability and absorbtion, more healthy roots through competing with root pathogens (**Vessey, 2003**). Bio fertilizers can play an essential role in fixing atmospheric nitrogen for production more plant growth promoting substances (**Soleimanzadeh *et al*., 2010; Akbari*et al*., 2011**). Saving Environment from pollution by chemical ferilizers can be achieved by expanding the use of bio-fertilizers as they play an important role in stabilizing main nutrients (NPK) in the rhizosphere and increasing their availability to plant absorption, so applying and developing sustainable agriculture techniques by bio fertilizers had great importance in mitigating environmental pollution and natural degradation **(Jalilian *et al*., 2012).** Also, **Kareem *et al.* (2012)** found that adding Biofertilizers led to better results than untreated treatments on leaf area, seed number/head, seed and oil yields.

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 at investigate the response of three sunflower genotypes (*Helianthus annus* L.), *i.e.* Giza-102, Sakha-53 and Line 120 to three bio-fertilizers Bio1= nitrogen fixing bacteria, NFB, Bio2= phosphate dissolving bacteria, PDB, Bio3= potassium edit facilitator "PEF". Sunflower seeds were obtained from Oil Crops Research Section, Field Crops Research Institute, while, bio-fertilizer were obtained from bacterilization Unite, Microbiology Soils Department, Water and Soil Research Institute, Agriculture Research Center, Giza, Egypt. Factorial experiment in split plot design with four replications was used each replicate and included 9 treatments which were the combination of three cultivars in the main plots and the three bio-fertilizer in the sub-plots. Ammonium nitrate fertilizer (33.5% N) was the source of chemical nitrogen fertilization in both seasons. The recommended rates of calcium superphosphate (15.5% kg P_2O_5) were applied during soil preparation at the rate of 200 kg fed^{-1}. Potassium sulfates (48% kg K_2O) at rate of 50 kg fed^{-1} was applied at five equal doses, the first was added after thinning and the other doses were supplied later every one week. Seeds of sunflower cultivar were washed and soaked for 30 min through the three bio-fertilizer bacteria (PDB, NFB, PEF). Arabic gum was used as an adhesive agent. Soil was directly irrigated after sowing to provide suitable moisture for inoculation. All the 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 among lines 50 cm was left to gain plot area of 10.5 m^2 (3.5 m long × 3 m wide, which gave approximately 84 plants/plot with 25 cm among drippers).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 each 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 plant height, stem diameter, number of leaves/plant, fresh and dry weight of leaves. 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 1-14 show the effect of biofertilizers (Bio1= nitrogen fixing bacteria, Bio2= phosphate dissolving bacteria, Bio3= potassium edit facilitator) application on sunflower genotypes (Sakha-53, Line 120, Giza-102) and their interactions at different growth periods *i.e.* 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 plant height, stem diameter, number of leaves per plant, leaves fresh (g) and dry weight (g) at most of samples in both seasons (Table 1). Giza-102 gave the highest value for each of plant height (61.85, 83.91, 129.00 and174.50 cm) in the first season, the same trend was recorded, also in the second season plant height recoded values of where in sunflower cultivar Giza-102 the highest value for plant height (80.50, 90.13, 103.20 and 179.70 cm) at 30, 40, 50 and 60 DAS, respectively. these results were obtained due to application of bio_3 treatment.

Effect of biofertilizers

There are significant effects due to biofertilizers on characters studied at all growth stages studied of sunflower in both seasons (Table 1). The heights values of plant height valued 63.26, 82.73, 130.40 and 176.10 cm in the first seasons, in the second seasons gave 79.93, 88.74, 103.74 and 184.60 cm) at 30, 40, 50 and 60 DAS, respectively.

Effect of interaction

Results in Table 2 show significant effect of genotypes × biofertilizers on all the studied characters at 30, 40, 50 and 60 DAS in 2018 and 2019 seasons. The tallest on plant height (77.17, 96.50, 141.70 and 183.00 cm in the first seasons, in the second seasons gave 88.00, 106.33, 122.30 and 184.60 cm at 30, 40, 50, 60 days after sowing, respectively. The same results were found with **Awad and Gharib (2009), Ibrahim and Genbehy (2009), Abd El-Motagally and Osman (2010), Martinez *et al*. (2010), Oyinloa *et al*. (2010), Irika (2015), Ravishankar and Malligawad (2017) and Khandekar *et al*. (2018).** They studied of sunflower seed production response to bio, organic and mineral fertilizers through pollination using *rhizobacterium* or microbes was conducted They recorded that sunflower plants which received 20 or 30 m^3 farm yard manure (FYM) with biofertilizers as mixer of Rhizobacterine and Microbin were among those that had plant height in the two seasons.

Genotypes Variation

Stem diameter (cm)

There are significant differences among sunflower genotypes stem diameter, (cm) at most of samples in both seasons Table 3. Giza-102 gave the highest value for each of 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 gave the highest value for each of stem diameter (1.500, 1.600, 1.774 and 1.956 cm) at 30, 40, 50, 60 DAS, respectively.

Effect of biofertilizers

There are significant effects of biofertilizers on characters studied at all growth stages of sunflower in both seasons (Table 3). The heights values of stem diameter 1.396, 1.563, 1.759 and 1.919 cm in the first seasons, and in the second seasons 1.496, 1.604, 1.763 and 1.959 cm at 30, 40, 50, 60 DAS, respectively were the result of the in effect of biofertilizers treatment Bio3.

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

Vegetative character	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
Biofertilizer	Bio1	47.06 b	77.96b	112.00b	168.10b	71.98b	78.98b	91.67b	167.60b
	Bio2	54.43ab	81.00ab	118.20ab	171.50ab	75.17ab	83.20ab	97.93ab	171.90ab
	Bio3	63.26a	82.73 a	130.40a	176.10a	79.93a	88.74a	103.90a	184.60a

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

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

Genotype	Biofertilizer	Plant height (cm) 2018				Plant height (cm) 2019			
Days		30	40	50	60	30	40	50	60
Sakha-53	Bio1	39.33hi	70.50cd	106.00k-o	162.50kl	67.00lmn	72.17kl	85.33jkl	161.40jkl
	Bio2	48.33e-i	72.50bcd	95.67no	170.50e-i	71.67h-l	79.00g-j	95.50f-i	171.50fgh
	Bio3	53.33d-h	77.33a-d	116.30f-l	173.20def	75.67d-j	81.83e-h	98.83e-i	174.00def
Line-120	Bio1	47.50f-i	80.00a-d	112.20j-m	174.30cde	76.50d-i	82.33e-h	96.33f-i	171.20fgh
	Bio2	57.67b-g	84.17a-d	116.00g-l	175.50b-e	77.00c-i	85.00d-h	104.80c-f	177.80bcd
	Bio3	69.00abc	88.83abc	133.20a-e	178.50abc	83.00abc	88.67cde	109.70bcd	179.50bc
Giza-102	Bio1	60.83b-g	88.83abc	129.70b-h	175.50b-e	78.67c-g	85.00d-h	102.00d-h	171.10fgh
	Bio2	62.33b-e	94.00ab	134.00a-d	180.30ab	81.33b-e	88.33cde	114.20ab	180.80b
	Bio3	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 biofertilizers on stem diameter (cm) of sunflower at 30, 40, 50 and 60 days after sowing in 2018 and 2019 seasons

Vegetative character	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
Biofertilizer	Bio1	1.163b	1.441b	1.563	1.719b	1.304b	1.426b	1.622b	1.833b
	Bio2	1.304ab	1.515ab	1.678	1.833ab	1.404ab	1.511ab	1.693ab	1.896ab
	Bio3	1.396a	1.563a	1.759a	1.919a	1.496a	1.604a	1.763a	1.959a

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 interaction

Results in Table 4 show significant effect of genotypes x biofertilizers interaction on Stem diameter at 30, 40, 50 and 60 DAS in 2018 and 2019 seasons. Stem diameter was larger and valued 1.567, 1.670, 1.900 and 2.130 cm in the first seasons, while in the second season they recorded 1.700, 1.733, 1.900, 2.133 and 184.60 cm at 30, 40, 50, 60 days after sowing, respectively. The same results were found with **Kandil *et al.* (2017); Ravishankar and Malligawad (2017); Braga *et al.* (2018) an**d **Khandekar *et al.* (2018)**. They recorded that sunflower plants which received 20 or 30 m^3 FYM with biofertilizers as mixer of Rhizobacterine and Microbin were among those that had larger stem diameter cm in the two seasons.

Number of Leaves Per Plant

Genotypes variation

There are significant differences among sunflower genotypes at most of samples in both seasons (Table 5). Giza-102 sunflower cultivar gave the highest 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 where in the highest value of number of leaves per plant recorded 16.28, 19.24, 21.81 and 25.35 at 30, 40, 50, 60 DAS respectively.

Effect of biofertilizers

There are significant effects of biofertilizers on number of leaves plant in both seasons (Table 5). The heights values of number of leaves/plant 14.50, 17.98, 20.52 and 23.59 were found in the first seasons, while in the second seasons the valued 16.46, 20.04, 22.20 and 25.11 at 30, 40, 50, 60 DAS, respectively.

Effect of interaction

Results in Table 6 show significant effect of genotypes × biofertilizers interaction on number of leaves / plant at 30,40,50and 60 DAS in 2018 and 2019 seasons. The greatest on number of leaves/plant 19.67, 21.17, 21.83 and 26.17 in the first seasons, and 18.50, 21.17, 23.17 and 27.33 in the second season at 30,40,50,60 days after sowing, respectively were the result of the interaction impact of genotype Giza-102 and the biofertilizers bio_3 .

Leaves fresh weight

Genotypes variation

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

Effect of biofertilizers

There are significant effects of biofertilizers on leaves fresh weight in both seasons (Table 7). The heights values of leaves fresh weight 79.95,97.73,117.30and138.86 in the first seasons, and 95.67,115.11,129.76 and 2153.35 in the second season were recorded at 30, 40, 50, 60 DAS respectively due to the biofertilizers treatment bio_3.

Effect of interaction

Results in Table 8 show significant effect of genotypes × biofertilizers interaction between genotype Giza-102 and bio_3 gave the largest on all the studied characters at 30, 40, 50 and 60 DAS in 2018 and 2019 seasons. Leaves fresh weight 123.36, 148.32, 189.13 and 206.23 in the first seasons, and the second seasons gave 135.47, 175.27, 205.11 and 240.16 at 30, 40, 50, 60 days after sowing, respectively.

The same results were found with **Hassan (2010)** they recorded that sunflower plants which received 20 or 30 m^3 FYM with biofertilizers as mixer of Rhizobacterine and Microbin were among those that had larger leaves fresh weight in the two seasons.

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

Genotype	Biofertilizers	Stem diameter (cm) 2018				Stem diameter (cm) 2019			
Days		30	40	50	60	30	40	50	60
Sakha-53	Bio1	1.117fg	1.47cde	1.63b-f	1.70def	1.233e-h	1.300ij	1.567hij	1.800fg
	Bio2	1.100g	1.40ef	1.57def	1.70def	1.167fgh	1.367g-j	1.633f-i	1.867d-g
	Bio3	1.167d-g	1.43def	1.57def	1.73def	1.400b-e	1.567b-e	1.700d-g	1.900c-f
Line-120	Bio1	1.317b-e	1.43def	1.60c-f	1.70def	1.333c-f	1.467d-h	1.600g-j	1.900c-f
	Bio2	1.450abc	1.53bcd	1.83ab	1.90bcd	1.400b-e	1.500d-g	1.667e-h	1.900c-f
	Bio3	1.483ab	1.60ab	1.80abc	1.90bc	1.467bcd	1.600a-d	1.667e-h	1.933b-e
Giza-102	Bio1	1.233d-g	1.50b-e	1.63b-f	1.90bcd	1.367cde	1.500d-g	1.667e-h	1.933b-e
	Bio2	1.317b-e	1.53bcd	1.70a-f	1.90bcd	1.500bc	1.600a-d	1.800a-d	2.00bc
	Bio3	1.567a	1.670a	1.900a	2.130a	1.700a	1.733a	1.900a	2.133a

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

Vegetative character	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
Biofertilizer	Bio1	12.96b	15.80b	18.33b	21.33b	14.09b	17.63b	20.54b	23.20b
	Bio2	13.39ab	16.30ab	19.54ab	22.24ab	15.39ab	18.94ab	21.39ab	24.20ab
	Bio3	14.50a	17.98a	20.52a	23.59a	16.46a	20.04a	22.20a	25.11a

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

Genotype	Biofertilizers	Number of leaves/plant 2018				Number of leaves/plant 2019			
Days		30	40	50	60	30	40	50	60
Sakha-53	Bio1	15.00cd	17.00hi	18.83e-h	20.83g-j	12.83kl	17.00hi	19.50kl	21.33kl
	Bio2	15.83bcd	18.00d-h	19.17d-h	22.33d-h	13.83ijk	19.00d-h	21.00f-j	23.00hij
	Bio3	16.67a-d	18.00abc	19.50def	22.50d-g	14.33h-k	20.00a-e	22.17b-f	23.67c-g
Line-120	Bio1	17.33abc	18.50e-h	18.83e-h	22.83c-g	14.17h-k	18.50e-h	21.00f-j	23.83e-i
	Bio2	18.00abc	19.17c-g	21.17abc	24.67abc	15.83d-h	19.17c-g	22.00b-f	24.83b-f
	Bio3	18.33ab	20.50a-e	20.98a-d	25.33ab	16.33c-g	20.50a-e	22.83a-d	26.17abc
Giza-102	Bio1	17.67abc	18.83d-h	20.00b-e	22.67d-g	15.67d-h	18.83d-h	21.50e-h	24.17b-f
	Bio2	18.00abc	20.17a-e	20.50a-d	23.50cde	15.83d-h	20.17a-e	22.00b-f	25.17ab
	Bio3	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 biofertilizers on leaves fresh weight of sunflower at 30, 40, 50 and 60 days after sowing in 2018 and 2019 seasons

Vegetative character	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
Biofertilizer	Bio1	61.32 c	72.97 c	87.97 c	99.80 c	73.85 c	82.56 c	97.28 c	108.32 c
	Bio2	70.28 b	85.34 b	100.37 b	115.43 b	80.65 b	95.21 b	106.6 b	125.47 b
	Bio3	79.95 a	97.73a	117.30a	138.86 a	95.67a	115.11 a	129.76 a	153.35a

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 biofertilizers on leaves fresh weight of sunflower at 30, 40, 50 and 60 days after sowing in 2018 and 2019 seasons

Genotype	Biofertilizer	Leaves fresh weight(g) 2018				Leaves fresh weight (g) 2019			
Days		30	40	50	60	30	40	50	60
Sakha-53	Bio1	80.47 e	84.18 f	98.51	114.32g	82.90 f	100.03 f	110.52g	124.4 g
	Bio2	90.72 c	105.15 d	116.1	133.5 f	97.29 d	113.72e	125.30 e	145.16 e
	Bio3	102.16 b	125.43 b	14530	190.07 b	118.23b	155.16 b	179.53b	218.99 b
Line-120	Bio1	75.63e	81.13f	74.32	111.17g	77.53f	96.83f	106.33g	121.43g
	Bio2	84.72c	100.11d	112.16	130.17f	94.31d	107.22e	120.17e	140.13.e
	Bio3	96.83b	125.43b	140.58	185.43b	113.26b	150.47b	175.73b	215.17b
Giza-102	Bio1	82.71 d	107.5 d	129.16	153.9 d	105.12 c	127.41d	145.18 d	160.40 d
	Bio2	99.27 b	122.11c	150.40	175.98 c	115.23b	145.07 c	165.43 c	183.41 c
	Bio3	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.

Leaves Dry Weight

Genotypes variation

There are significant differences among sunflower genotypes at most of samples in both seasons (Table 9). Giza-102 gave the highest value of leaves dry weight 22.80, 30.14, 35.08 and 42.19 in the first seasons, the same trend was recorded in the second season and the values of leaves dry weight were 31.36, 32.45, 40.16 and 46.62 at 30, 40, 50, 60 DAS, respectively.

Effect of biofertilizers

There are significant effects of biofertilizers on leaves dry weight sunflower in both seasons (Table 9). The heights values of leaves dry weight 25.13, 31.12, 37.19 and 42.05 recorded in the first seasons, and in the second seasons 33.14, 35.12, 42.03 and 49.71 at 30, 40, 50, 60 DAS, respectively were obtained due to application of bio_3 treatment.

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

Vegetative character	Treatment	Leaves dry weight(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
Biofertilizer	Bio1	19.63 c	28.17 b	32.75 b	35.68 c	30.11 c	30.97 c	35.21 c	39.40 c
	Bio2	23.87 b	28.83 b	32.78 b	37.23 b	32.45 b	31.25 b	37.17 b	45.12 b
	Bio3	25.13 a	31.12 a	37.19 a	42.05 a	33.14 a	35.12 a	42.03 a	49.71 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 interaction

Results in Table 10 show significant effect of genotypes × Biofertilizers interaction on leaves dry weight at 30, 40, 50 and 60 DAS in 2018 and 2019 seasons. The heavyset on leaves dry weight 35.74, 37.25, 44.20 and 55.87 in the first seasons, in the second seasons gave 39.74, 42.54, 56.18 and 65.23 at 30, 40, 50, 60 days after sowing, respectively were the resultant of interaction impact of Giza-102xBio_3 treatment. The same results were found by and **Osman (2010), Hassan (2010), Ravishankar and Malligawad (2017) and Cechin *et al.* (2018)**. They recorded that sunflower plants which received 20 or 30 m^3 farmyard manure (FYM) with biofertilizers as mixer of Rhizobacterine and Microbin were among those had high leaves dry weight in the two seasons

Yield and Yield Components

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

Genotypes variation

There are significant differences among sunflower genotypes 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 season, respectively.

Effect of biofertilizers

There are significant effects of biofertilizers on Head diameter, 100 seed weight and seed oil content (%) in both seasons (Table 11). The biofertilizers treatment Bio_3 gave the heights values of head diameter (cm) 17.43, 19.10, 100-seed weight (g) 5.05, 5.95 and seed oil content (%) 39.92,40.53 in the first and second season, respectively.

Effect of interaction

Results in Table 12 show significant effect of genotypes × Biofertilizers interaction on head diameter, 100 seed weight and seed oil content (%) studied in the harvest in 2018 and 2019 seasons. There were significant effect of sunflower Genotype x Biofertilizers interaction for yield components characters in both seasons except seed oil content (%) 32.25, 33.63 interaction between sunflower genotype Giza-102 and biofertilizer (Bio3) produced heads with larger diameter as well as heavier seed weight in the first and second seasons, respectively. Similar results have been reported by **Solimanzadeh *et al.* (2010), Mahrous *et al.* (2014), Gul and Kara (2015) and Kandil *et al.* (2017)**. They recorded that sunflower plants which received 20 or 30 m^3 farmyard manure (FYM) with biofertilizers as mixer of Rhizobacterine and Microbin were among those that had larger head weight g, head diameter (cm), 100-seed weight (g) and Seed weight(plant, seed and oil yields (kg/fad.) in the two seasons.

Table 10. Effect of interaction between genotypes and biofertilizers on leaves dry weight of sunflower at 30, 40, 50 and 60 days after sowing in 2018 and 2019 seasons

Genotype	Biofertilizer	Leaves dry weight(g) 2018				Leaves dry weight(g) 2019			
Days		30	40	50	60	30	40	50	60
Sakha-53	Bio1	26.14 e	30.93 ef	35.91 f	35.28 gh	32.19	33.26 f	37.19 g	50.61c
	Bio2	30.80 c	32.47d	36.15 e	42.64 cd	33.81	35.15 e	39.65 f	54.45 b
	Bio3	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	Bio1	22.18 e	26.54ef	32.41e	38.29cd	29.89	30.93f	33.15g	45.63c
	Bio2	25.34 c	28.14d	37.53b	45.31b	30.74	31.18e	36.46f	50.19b
	Bio3	27.13b	31.52b	24.13 l	21.09 l	32.24	35.62b	45.11b	60.71a
Giza-102	Bio1	26.75 d	31.12 e	37.05 d	43.65 c	33.01	34.44 d	45.17 d	50.16 c
	Bio2	30.19 c	33.45 c	38.79 c	47.93 b	35.28	35.97 c	46.34 c	52.10 b
	Bio3	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.

Table 11. Effect of genotypes, and biofertilizers on head diameter (cm), 100-seed weight (g) and seed oil content (%) of sunflower in2018 and 2019 seasons

Vegetative character	Treatment	Head diameter (cm)		100-seed weight (g)		Seed oil content (%)	
Seasons		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
Biofertilizer	Bio1	14.82b	17.20b	3.98 c	4.90 c	38.58 b	39.13 b
	Bio2	15.83b	18.07ab	4.51 b	5.41 b	36.81 c	37.51 c
	Bio3	17.43a	19.10a	5.05 a	5.95 a	39.92 a	40.53 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 12. Effect of interaction between genotypes and biofertilizers on; head diameter (cm); 100 seed weight (g) and Seed oil content (%) of sunflower in2018 and 2019 seasons

Genotype	Biofertilizer	Head diameter (cm)		100-seed weight (g)		Seed oil content (%)	
Seasons		2018	2019	2018	2019	2018	2019
Sakha-53	Bio1	16.13c-f	16.87ghi	4.24 j	5.93 e	38.18ab	39.87bc
	Bio2	18.00b	18.40b-f	4.54 h	6.31 d	38.18ab	39.87bc
	Bio3	20.23a	19.53ab	5.45 e	7.13 b	38.18ab	39.87bc
Line-120	Bio1	16.20c-f	17.33f-i	3.97j	5.71e	34.27cd	36.01ef
	Bio2	17.60bc	18.00c-h	4.35h	6.18d	34.27cd	36.01ef
	Bio3	18.23b	19.00abc	5.27e	7.09b	34.27cd	36.01ef
Giza-102	Bio1	16.40c-f	16.80hi	6.14 c	6.24 d	32.25e	33.63g
	Bio2	17.23bcd	18.67a-e	6.52 b	6.62 c	32.25e	33.63g
	Bio3	21.07a	22.56a	7.49 a	8.02 a	32.25e	33.63g

Genotypes variation

There are significant differences among sunflower genotypes in both seasons (Table 13). Giza-102 gave the highest value for each of seed weight/plant 26.42, 44.75 g, seed yield 1056, 1790 kg/fad., and oil yield 2414, 3943kg fad^{-1} in the first and second seasons, respectively.

Effect of biofertilizers

There are significant effects of biofertilizers on seed weight/plant (g), seed yield (kg/ fad.), oil yield (kg/$fad.^{-1}$), in both seasons (Table 13). The heights values of seed weight/plant 27.15, 46.25 g, seed yield 1.086, 1.850 kg/fad., and oil yield 238.6, 378.3 kg fad^{-1} in the first and second season, respectively. The increase in the yield components, seed and oil yield in the inoculated plants could be attributable to the exudation of plant growth regulators (PGRs), such as auxins and gibberellin and cytokinin by Azotobacter and Azospirillum **Vessey (2003)** reported that Azotobacter and Azospirillum increase the available nitrogen in the soil which could enhance the grain number. Similar results were reported about the effect biofertilizers **(Soleimanzadeh *et al*., 2010; Akbari *et al*., 2011; Jalilian *et al*., 2012)** on grain and oil yield of different crop plants.

Effect of interaction

Results in Table 14 show significant effect of genotypes × biofertilizers interaction on each of seed weight/plant, seed and oil yields/fad., at harvest in 2018 and 2019 seasons. The tallest on seed weight/plant 26.97, 42.68 g, seed yield 1.078, 1.707 kg/fad, and oil yield 0.797, 0.830 kg/fad^{-1} in the first and second seasons, respectively were resultant of interaction treatment Giza 102 cultivar and biofertilizers (Bio3). The same results were found by **El-Aref *et al.* (2011), Shehzad and Maqsood (2015), Dhillon *et al.* (2017), Bagheri *et al.* (2018) and Schultz *et al.* (2018)**.They recorded that sunflower plants which received 20 or 30 m^3 farm yard manure (FYM) with biofertilizers as mixer of Rhizobacterine and Microbin were among those that had higher seed weight/plant (g), seed yield (kg/fad.), and oil yield(kg/$fad.^{-1}$) in the two seasons.

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

Vegetative character	Treatment	Seed weight/plant (g)		Seed yield (kg/fad.)		Oil yield (kg/$fad.^{-1}$)	
Seasons		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
Biofertilizers	Bio1	22.99 c	40.75 c	0.919 c	1.630 c	168.1 c	260.1 c
	Bio2	24.73 b	42.75 b	0.989 b	1.710 b	193.8 b	310.5 b
	Bio3	27.15a	46.25 a	1.086 a	1.850 a	238.6 a	378.3 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 14. Effect of interaction among genotypes and biofertilizers on seed weight/plant (g), seed yield (kg fad.$^{-1}$), seed oil content (%), and oil yield (kg fad.$^{-1}$) of sunflower for sowing in 2018 and 2019 seasons

Genotype	Biofertilizer	Seed weight/ plant (g)		Seed yield (kg/fad.)		Oil yield (kg/fad.$^{-1}$)	
Seasons		2018	2019	2018	2019	2018	2019
Sakha-53	Bio1	20.52 g	35.44h	0.820 g	1.417 h	0.736abc	0.769abc
	Bio2	22.28 f	37.11 f	0.891 f	1.484 f	0.837ab	0.876ab
	Bio3	25.18 b	41.36 d	1.007 b	1.654 d	0.787ab	0.861ab
Line-120	Bio1	19.96 g	34.21	0.798	1.368	0.627bcd	0.660b-e
	Bio2	21.84 f	36.18	0.873	1.447	0.588b-h	0.589b-h
	Bio3	24.61 b	40.61	0.984	1.624	0.567b-g	0.597b-g
Giza-102	Bio1	21.16 c	36.92 c	0.846 c	1.476 c	0.554b-f	0.579b-f
	Bio2	23.76 b	38.84 b	0.950 b	1.553 b	0.580b-e	0.605bcd
	Bio3	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.

REFERENCES

Abaza, Gh.M.S.M. (2010). Effect of some agricultural practices on some sunflower genotype characters induced by gamma irradiation. M.Sc. Thesis, Crop Sci. Dept., Fac. Agric., Minofia Univ.,

Abd El-Motagally, F.M.F. and Osman, E.A. (2010). Effect of nitrogen and potassium fertilization combinations on productivity of two Sunflower cultivars under East of El-Ewinate conditions. Ame.-Euras. J. Agric. Environ. Sci., 8 (4): 397-401.

Awad, M.M. and H.S. Gharib (2009). Productivity of some open pollinated sunflower populations under different nitrogen fertilizer rates in North Delta. J. Agric. Res., 35(2): 503-521.

Akbari, P.; Ghalavand, A.; Sanavy, A.M.; Agha Alikhani, M. and Kalkhoran, S.S. (2011). Comparison of different nutritional levels and the effect of plant growth promoting rhizobacteria (PGPR) on the grain yield and quality of sunflower. Aust. J. Crop Sci., 5 : 12.

AOAC (2012). Official Method of Analysis, kjeldahl method No. 984.13, Chapter 4, p. 31, 19th Ed. Tecator Application Notes AN 300.

Bagheri, F.; Kazemeini, S.A.; Bahrani, M.J. and Heidari, B. (2018). Effect of nitrogen, wheat residues, and compost rates on the growth and yield of sunflower. Ukrainian J. Ecolo., 8 (1): 736-744.

Braga, D.F.; Oliveira, F.H.T.; Santos, H.C.; Araújo, A.P. and Zonta, E. (2018). Nitrogen and phosphorus fertilization of sunflower crop in alkaline Cambisol. Revista Brasileira de Engenharia Agricola Ambiental, 22 (2): 101-106.

Cechin, I.; Gonzalez, G.C.; Corniani, N. and Fumis, T.D.F. (2018). The sensitivity of sunflower (*Helianthus annuus* L.) plants to UV-B radiation is altered by nitrogen status. Santa Maria, 48 (2):1-6.

Dhillon, B.S.; Sharma, P.; Sharma, S. and Sharma, S. (2017). Oil yield and fatty acid composition of spring sunflower as affected by sowing date, Intra row spacing and nitrogen dose. Ind. J. Agric. Biochem., 30 (2): 135-140.

Duncan, D.B. (1955). Multiple Range and Multiple F. test. Biometrics, (11):1-24.

El-Aref, Kh.A.O.; Abo-El-Hamd, A.S.A. and Abd El-Monem, A.M.A. (2011). Influence of filter MUC cake fertilization under low levels of nitrogen on yield and its components for tow sunflower cultivars. Mansoura J. Plant Prod., 2 (2): 165 – 178.

El-Sarag, E.I. (2007). Influence of plant population and nitrogen fertilization levels on performance of some sunflower cultivars under North Sinai condition. Ann. Agric. Sci., Ain Shams Univ., Cairo, 25 (1): 113-121.

Gul, V. and Kara, K. (2015). Effects of different nitrogen doses on yield and quality traits of common sunflower (*Helianthus annuus* L.). Turkish J. Field Crops, 20 (2):159-165.

Hama, S.J. (2015). Response of growth, yield and yield components of two sunflower varieties (*Helianthus annuus* L.) to nitrogen fertilization. J. ZankoiSulaimani, 17(4):239-250.

Hassan, T.H.A. (2010). Bio and mineral fertilization studies on Sunflower under North Sinai conditions. Ph.D. Thesis, Fac. Environ. Agric. Sci., Suez Canal Univ.

Irika, M.A. (2015). Effect of organic and inorganic nitrogen sources on growth, yield and oil content of sunflower grown in highly weathered soils of Morogoro. M.Sc. Thesis, Fac. Agric., Nairobi. Univ.

Jalilian, J.; Sanavy, A.M.M.; Saberali, S.F. and Aslian, K. (2012). Effects of Bio and chemical nitrogen fertilizer on grain and oil yield of sunflower (*Helianthus annuus* L.) under different rates of plant density., Field Crops Res., 127: 26-34.

Kandil, A.A.; Sharief, A.E. and Odam, A.M.A. (2017). Response of some Sunflower hybrids (*Helianthus annuus* L.) to different nitrogen fertilizer rates and plant densities. Int. J. Environ., Agric. and Biotechnol., 2 (6):2456-1878.

Kareem, A.A.; Hamzah, A.H. and Hadawee, A.F. (2012). The effect of organic, bio and chemical fertilizer on growth and yield of sunflower (*Helianthus annuus* L.). Euphrates J. Agric. Sci., 4 (2): 130-137.

Khandekar, S.D.; Ghotmukale, A.K.; Dambale, A.S. and Suryawanshi, S.B. (2018). Growth, yield and economics of sunflower (*Helianthus annuus* L.) as influenced by bio fertilizer and fertilizers levels. J. Current Microbial and Appl. Sci., (6): 1564-1571.

Lahuf, A.A.; Kareem, A.A; Al-Sweedi, T. M. and Alfarttoosi, H.A. (2019). Evaluation the potential of indigenous biocontrol agent Trichoderma harzianum and its interactive effect with nanosized Zn Oparticles against the sunflower damping-off pathogen, Rhizoctonia solani. IOP Conf. Series: Earth and Environ. Sci., 365 - 380.

Lomascolo, A.; Uzan-Boukhris, E.; Sigoillot, J. and Fine, F. (2012). Rapeseed and sunflower meal: a review on biotechnology status and challenges. Appl. Microbiol. Biotechnol., 95: 1105–1114.

Mahrous, N.M.; Ragab, A.A.; Abotaleb, H.H.; Taha, M.H. and El-Metwally, M.S. (2014). Effect of inorgantic, organic and bio fertilizers on yield and yield components of sunflower under newly reclaimed Soils. J. Plant Prod., Mansoura Univ., 5 (3): 427-441.

Mohamed, B.; Mounia, K.; Aziz, A.; Ahmed, H.; Rachid, B. and Lotfi, A. (2018). Sewage sludge used as organic manure in Moroccan sunflower culture effects on certain soil properties, growth and yield components. Sci. Total Environ., 627 (1): 681–688.

Oyinlola, E.Y.; Ogunwole, J.O. and Amapu, I.Y. (2010). Response of sunflower (*Helianthus annuus* L.) to nitrogen application in A Savanna Al Fisol. Helia, 33(52): 115-126.

Ravishankar, G. and Malligawad, L.H. (2017). Response of sunflower to different N/P fertilizer ratios and levels of nitrogen and phosphorus. Int. J. Current Microbiol. and Appl. Sci., 6(8): 980-986.

Schultz, E.; DeSutter, T.; Sharma, L.; Endres, G.; Ashley, R.; Bu, H.; Markell, S.; Kraklau, A. and Franzen, D. (2018). Response of sunflower to nitrogen and phosphorus in North Dakota. Agron. J., 110 (2): 1-11.

Snedecor, G.W. and Cochran, W.G. (1956). Statistical Methods Applied to Experiments in Agriculture and Biology. 5th Ed. Ames, Iowa: Iowa State Univ.

Soleimanzadeh, H.; Habibi, D.; Ardakani, M.R.; Paknejad, F. and Rejali, F. (2010). Response of sunflower (*Helianthus annuus* L.) to inoculation with Azotobacter under different nitrogen levels. Ame. Eurasian J. Agri. Env. Sci., 7(3): 265-268.

Vessey, J.K. (2003. Root Growth, Mycorrhizal Frequency and Soil Microorganisms in Strawberry as Affected by Biopreparations. Plant and Soil, 255: 571-586.

الملخص العربي

تأثير إضافة الأسمدة الحيوية علي بعض التراكيب الوراثية لدوار الشمس

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أجريت دراسة حقلية خلال الموسم الصيفي لعامي 2018 و2019 م في المزرعة التجريبية بكلية العلوم الزراعية البيئية بالعريش جامعة العريش، محافظة شمال سيناء، مصر وذلك بهدف دراسة استجابة بعض التراكيب الوراثية من دوار الشمس (سخا 53 وجيزة 102 وسلالة 120) لثلاث معاملات من التسميد الحيوي باستخدام بكتيريا مثبتة للنيتروجين، بكتيريا مذيبة للفوسفور، وبكتيريا ميسرة للبوتاسيوم) وكان الري باستخدام نظام الري بالتنقيط وتراوحت ملوحة مياه الري بين 4500 إلى 5500 جزء في المليون واستهدفت الدراسة إلى التوصل إلى أفضل توليفة من التسميد الحيوي للسلالات المستخدمة لمعظمة إنتاج دوار الشمس من الزيت والبذور. وكانت أهم النتائج هي تفوق صنف جيزة 102 على صنف سخا 53 وسلالة 120 في كل صفات النمو الخضري (ارتفاع النبات/سم، قطرالساق/سم، عدد أوراق النبات/نبات، الوزن الخضري والجاف للأوراق/جم)، ومساهمات المحصول ونسبة الزيت وكذلك محصول البذور، وخلصت الدراسة إلى أن التسميد الحيوي وجد أن المعاملة Bio3 (بكتيريا ميسرة للبوتاسيوم) 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 % للزيت، وزن بذور النبات جم، وزن محصول البذور ب كجم/ف، محصول الزيت كجم/ف) في حين أن المعاملة Bio1 (بكتيريا المثبتة للنتروجين) أعطت أعلي نسبة زيت. ولذلك لتعظيم إنتاج بذور دوار الشمس تحت ظروف المناطق شبة الجافة يمكن زراعة الصنف جيزة 102 مع معاملته بالتسميد الحيوي لعنصري النتروجين والبوتاسيوم.

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