

EFFECT OF BIO- AND NITROGEN FERTILIZERS ON YIELD AND ITS COMPONENTS OF TWO SUNFLOWRE CULTIVARS (*Helianthus annus*, L).

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ABSTRACT

In order to study the response of two cultivars of sunflower (Sakha-53 and Giza-102) to inoculation with phosphate dissolving bacteria (phosphorine) and biological nitrogen fixation bacteria (Cerealin) under different nitrogen fertilizer levels i.e. (15, 25 and 35 kg N /fad.). The main finds could be summarized as follows: Two field experiments were conducted at Agricultural experimental farm of AL –Azhar Univ. at Assiut, during 2012 and 2013 seasons.

The results revealed that sunflower cultivars exhibited significant differences in all studied traits except No. of seeds per plant. Plants of Sakha-53 were surpassed significantly Giza-102 in all studied traits in the two growing seasons.

Increasing nitrogen fertilizer levels up to 35 kg N /fad significant increased all traits under study except seed oil percentage was decreased with increasing N levels up to 35 kg N /fad in both seasons.

Results indicated that the inoculation of sunflower seed with phosphate dissolving bacteria (phosphorine) or with N₂- fixation bacteria (Cerealin) enhanced significantly all studied traits over the control except seed oil percentage in both seasons. Seed inoculation with cerealin gave highest means of all studied traits.

The interaction between cultivars and nitrogen fertilizer rates had a significantly effected plant height and seed yield ton/fad. in both seasons as well as stem diameter and oil yield kg/fad in the first season only and seed oil percentage in the second season. The interaction between cultivars and bio-fertilizer significantly affected stem diameter, seed and oil yields /fad in both seasons, plant height and head diameter in the first season only and seed oil percentage in the second only. The interaction between nitrogen fertilizer rates x bio-fertilizer significantly affected stem diameter, number of seed per head, seed weight per head and seed yield ton/fad. in two growing seasons and plant height, head diameter and oil yield ton/fad. in the first season and seed oil percentage in the second season only.

In general it could be concluded that highest seed and oil yield/ fad was obtained from Sakha-53 cultivar when received 35 kg N /fad. and inoculation with cerealin under Assiut conditions.

INTRODUCTION

Sunflower (*Helianthus annus*, L.) is becoming an important source of edible vegetable oil through the world due to its no cholesterol and high unsaturated fatty acids content (Leland, 1996 and Khalifa and Awad 1997). In addition, due to its short growing season and need to fill the gap between the vegetable oils production and consumption it receives considerable attention in Egypt especially, in the reclaimed areas.

Seed yield of sunflower is affected by many factors, of which variety, nitrogen and bio-fertilizer play an important role in determining productivity of

sunflower. Abou-Khadra *et al.* (2002), reported that sunflower hybrids (Vidoc, Alamo, Eruflower and Malabar) significantly differed in their growth, yield and its attributing characteristics. Saleh *et al.* (2004) revealed that sunflower cultivars (Maik, Vidoc and Eruflower) significantly differed in all characters yield and yield components under study. El- Mohandes *et al.* (2005) showed that sunflower hybrids exerted a highly significant influence on all traits (Vegetative growth traits, seed yield and yield component) in the tow growing seasons. Where, Hybrid-102 surpassed Hybrid-20 in all traits except oil %. Awad and Ghrib (2009) indicated that sunflower genotypes exhibited significant differences in all studied traits. Sakha-53 cultivar and Pop.770 were among those having great head diameter, seed yield / fed., and seed oil yield /fed. The commercial cultivar Sakha-53 surpassed all other genotypes in 100-seed weight. On the other hand, Pop.770 exceeded all other genotypes in seed oil content. Sakha-53 cultivar and Pop.770 out yielded all other genotypes in oil yield / fed.

Nitrogen fertilization is one of the most important factors to increase seed and oil yields of sunflower. Sunflower crop requires a suitable amount of nitrogen for each type of soil to produce the maximum seed and oil yields. Sarmach *et al.* (1994) concluded that size and dry weight of head, 100- seed weight, seed yield /plant and seed yield/ha were highest with 80 kg N + 40 kg P₂O₅ /ha. Kumara *et al.* (2003) reported that application of N at 60 kg N /ha greatly improved plant height, head diameter, number of seeds per head, seed and oil yields. Gandahi and Oad (2005) found that plant height, head diameter, 100- seed weight and seed yield were increased with increasing nitrogen fertilizer rate up to 100 kg N /ha. Sayed *et al.* (2006) concluded that increasing nitrogen fertilizer rate up to 80 kg N /ha. increased seed and oil yields of sunflower. Increasing nitrogen fertilization significantly increased plant height, leaf area /plant, dry weight /plant, days to flowering, head diameter, 100- seed weight, seed and oil yields, but decreased seed oil % (Azouz and Selim, 2007, Awad and Gharib, 2009 and Ibrahim and El-Genbehy, 2009).

Using the biological fertilizer such as phosphate dissolving bacteria and bio-nitrogen fixation bacteria aims mainly to reduce using of mineral fertilizers in order to reduce the environmental pollution (Nawar, 1994). Radwan (1996) observed that inoculation of sunflower seed with phosphate dissolving bacteria significantly increased number and weight of seeds /head, head diameter and seed index in addition to sunflower growth attributes. The results obtained by Keshta and El- Kholy (1999) indicated that the application of inorganic nitrogen and bio-nitrogen fertilizers for sunflower increased plant height, head diameter, 100- seed weight, seed yield/fed. and seed oil content. Sharief *et al.* (2000) reported that applying either the fertilization regimes (Ceralin-Phosphorine) along with 50 kg N /fed. or 70 kg N /fed. (as control) for wheat produced the heaviest grain weight, number of grains/spike, number of spikes/m² and grin yield/fad. Abou Khadrah *et al.* (2002) found that inoculation of sunflower seed with phosphorine as bio-fertilizer significantly increased head diameter, number of seeds /head, seed oil content, seed yield /plant as well as seed and oil yields/fed. but did not

show any significant effect on plant height, 100- seed weight, and seed husk percent.

The objectives of this study is aimed to evaluate the response of sunflower cultivars to phosphorine (phosphate dissolving bacteria) and Cerealin (bio-nitrogen fixation bacteria) under low N-fertilizer levels.

MATERIALS AND METHODS

Two field experiments were conducted at the Experimental farm, faculty of Agriculture, AL –Azhar University at Assiut Governorate. Egypt during 2012 and 2013 seasons. This research was aimed to study the response of two sunflower cultivars (Sakha-53 and Giza-102) to inoculation with biological nitrogen fixation bacteria Cerealin (Cer.) and phosphate dissolving bacteria phosphorine (phos.) under low nitrogen fertilizer levels i.e. 15, 25 and 35 kg N /fed. in the form of ammonium nitrate 33.5% N. Planting was done on the 3 and 6 June in 2012 and 2013 seasons, respectively using seeds obtained from the Agriculture Research Center, Giza. The plants were later thinned to soil secure one plant per hill before the first irrigation (21 days after sowing). The preceding crop was Egyptian clover (*Trifolium alexandrinum* L.) in the 1st and 2nd sowing seasons. The experimental unit consisted of 5 ridges, 3.5 m long and 60 cm apart, occupying an area of 10.5 m² (1/400 fad.).

Randomized complete block design using split-split plot arranged was applied in three replicates where sunflower cultivars were assigned to the main plot, while nitrogen and bio-fertilizers were distributed randomly in the sub and sub-sub plot, respectively. The Mechanical and chemical analyses of experimental site are presented in Table (1).

Table 1: The Mechanical and chemical analysis of soil field experiments

Mechanical analysis	2012	2013	Chemical analysis	2012	2013
Sand (%)	24.50	25.30	Organic matter (%)	0.97	1.02
Silt (%)	39.00	39.40	Available N (ppm)	74.50	76.30
Clay (%)	36.50	35.30	Available P(ppm)	9.60	10.56
Soil texture	Clay loam	Available K (ppm)	355.15	363.25	
		Ph	7.76	7.98	
		E.C. (ds. m ⁻¹)	1.17	1.18	
		Total CaCO ₃ (%)	2.85	2.60	

Different nitrogen rates were added in two equal split doses, where the first one was added after thinning time and before irrigation, while, the second dose was added before the second irrigation.

Phosphorin is a commercial bio-fertilizer containing active and Cerealin is also a commercial bio-fertilizer containing active bio-nitrogen fixation bacteria, produced by the general organization for Agricultural Equalization Fund, Ministry of Agriculture and Land Reclamation. The wetted sunflower seed was thoroughly inoculated with different inoculation treatments just before planting.

Arabic gum was used as an adhesive agent. Soil was directly irrigated after sowing to provide suitable moisture for the inocula. All other cultural practices for recommended growing sunflower were conducted as recommended.

At harvest, samples of five guarded plants were taken at random for each sub-sub plot and the following characters were measured:

1 - Plant height (cm).

2- Stem diameter (cm).

3- Head diameter (cm).

4- Number of seeds /head. It was calculated using the following formula:

$$\text{Number of seeds/head} = \frac{\text{Seed weight /plant}}{\text{Seed index}} \times 100$$

5- Weight of seed / head (g).

6-1000- seed weight (g).

7- Seed yield / fad (ton) was determined from the plants in the inner ridges of each sub-sub plots.

8- Seed oil percentage, was determined using Soxhlet apparatus according to **A.O.A.C. (1995).**

9- Oil yield /fad (kg), was determined by multiplying seed yield (kg/fad.) by seed oil percentage.

$$\text{Oil yield kg /fad} = \frac{\text{Oil \%} \times \text{seed yields / fad.}}{100}$$

Obtained data were subjected to the statistical analysis as usual technique of analysis of variance (ANOVA) of the split-split plot design. The treatment means were compared using the least significant differences (L. S. D.) procedure as mentioned by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect of cultivars performance:

Results presented in Tables 2, 3, 4, 5 and 6 indicate that sunflower cultivars Sakha-53 and Giza-102 differed significantly in yield and its attributes i.e. plant height, stem diameter, head diameter, 1000-seed weight, seed weight per head, seed yield ton/ fad., seed oil percentage and oil yield per fad. in both seasons. Sakha-53 had higher all characters under study than Giza-102 cultivar in both seasons. This mean that the difference between cultivars is mainly due to the difference in their genetic make up and their reaction to the environments condition prevailing during it growth. These results agree meant with those obtained by Awad and Gharib (2009), Abdel-Motageally and Osman (2010), Abdel- Monem (2011) and Hassanen *et al* (2013).

Effect of nitrogen levels:

As shown in Tables 2, 3, 4, 5 and 6 results indicated that increasing nitrogen level from 15 to 35 kg N /fad. significantly increased studied traits components in both growing seasons except oil % which deceased with

increasing nitrogen level. Maximum values of plant height, stem diameter, head diameter, No. of seeds per head, 1000-seed weight, seed weight per head, seed yield ton/ fad. seed oil yields per fad. were observed with adding 35 kg N /fad. The increase in these characters with the increase of nitrogen level might due to the role of nitrogen in activating the growth and yield components. This reflects the important of nitrogen in building up the photosynthetic area of sunflower plants and consequently accumulation of more dry matter, which is reflected in seed yield and its components. Increasing nitrogen level up to 35 kg N /fad. gradually increased oil yield/fad. Similar results were obtained by Abou Khadrah *et al* (2002), Mojiri and Arzani (2003), Killi (2004), Ozer *et al* (2004), Osman and Awed (2010) and Hassanen *et al* (2013).

Effect of seed inoculation:

Results presented in Tables 2, 3, 4, 5 and 6 clearly reveal that the inoculation of sunflower seed with phosphate dissolving bacteria (phosphorine) or with N₂- fixation bacteria (Cerealain) or with bio-fertilizers significantly enhanced all the studied traits over the control (un inoculated) in both seasons except oil% which decreased. It is clear from the present data that the seed inoculation with cerealain gave the highest mean values of all studied characters. Generally, results pointed out to a beneficial effect of seed inoculation with N₂- fixation or/and phosphate dissolving bacteria on yield and yield components might be attributed to the fixation of nitrogen, the soluble mono-calcium phosphate and /or to the production of certain plant growth promotion substances by these bacteria as well as supplying sunflower plants with its requirements during different growth stages. The increase in sunflower seed yield resulted by the inoculation with phosphorine and cerealain might be due to the favorable effect of bio-fertilizers on plant height, head diameter and seed yield per plant. Also, the increase in oil yield might be attributed to greater seed yield per fad. These results are similar to those reported by Sharief *et al* (2000), Abou Khadrah *et al* (2002), Mohamed (2003), Abdalla *et al* (2007), El-Aref *et al* (2012) and Hassanen *et al* (2013).

Interactions effect:

Results in Tables 2, 3, 4, 5 and 6 indicated that the interaction between cultivars and nitrogen levels had a significant effect on plant height and seed yield ton/fad. in both seasons as well as on stem diameter and oil yield per fad. in the first season and seed oil percentage in the second seasons. Where the highest mean values of mentioned traits were obtained from Sakha-53 cultivar and 35 kg N /fad. except seed oil percentage in both seasons. The interaction between cultivars and bio-fertilizer on stem diameter, seed yield per fad. and oil yield per fad. was significant in both season and plant height and head diameter in the first season only, Where the highest values were obtained from Sakha-53 and inoculation with cerealain. The interaction between nitrogen levels and bio-fertilizer was significant on stem diameter, no. of seed per head, seed weight per head and seed yield per fad. in both seasons and plant height, head diameter and oil yield per fad. in the first season and seed oil percentage in the second season only. The interaction among cultivars, nitrogen levels and bio-fertilizer was significant influence on stem diameter and seed yield per fad. in both seasons, and plant height and oil yield per fad. in the first season only.

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In general, it could be concluded the heights seeds and oil per fad. was obtained from Sakha-53 when received 35 kg N /fad. and inoculation with Cerealin under Assiut conditions.

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تأثير التسميد الحيوي والنيتروجيني علي المحصول ومكوناته لصنفين من زهرة الشمس

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أجريت تجربتان حقليتان بالمزرعة البحثية بكلية الزراعة- جامعة الأزهر- فرع أسيوط خلال موسمي ٢٠١٢، ٢٠١٣ م بهدف دراسة تأثير التلقيح بالفوسفورين والسيريالين تحت مستويات مختلفة من التسميد النيتروجيني (١٥، ٢٥ و ٣٥ كجم/ن/ف) وأثر ذلك علي المحصول ومكوناته لصنفين من زهرة الشمس (سحا-٥٣ وجيزة ١٠٢) وقد استخدم تصميم القطاعات كاملة العشوائية بترتيب القطع المنشقة مرتين في ثلاث مكررات، حيث وزعت الأصناف في القطع الرئيسية بينما وزعت معدلات التسميد الأزوتي والحيوي عشوائيا علي القطع الشقية الاولى والشقية الثانية علي الترتيب.

- أظهرت النتائج أنه يوجد إختلافا معنويا بين أصناف زهرة الشمس في كل الصفات تحت الدراسة عدا عدد البذور بالقرص حيث تفوق الصنف سحا ٥٣ علي جيزة ١٠٢- في كل الصفات المدروسة مثل إرتفاع النبات وقطر الساق والقرص ووزن ال ١٠٠٠ بذرة ومحصول البذور للنبات والفدان والنسبة المئوية للزيت ومحصول الزيت للفدان في كلا الموسمين.

- أشارت النتائج الي أن زيادة معدلات التسميد الأزوتي من ١٥ إلي ٢٥ او ٣٥ كجم/ن/فادت إلي زيادة معنوية في كل الصفات المدروسة، بينما نقصت النسبة المئوية للزيت بالبذور بزيادة التسميد الأزوتي في الموسمين.

- أظهرت النتائج أن إستعمال التسميد الحيوي وخاصة السيريالين إلي زيادة معنوية في إرتفاع النبات وقطر الساق والقرص وعدد البذور بالقرص ووزن ال ١٠٠٠ بذرة ومحصول النبات من البذور ومحصول الفدان من البذور والزيت، بينما نقصت النسبة المئوية للزيت بالبذور مقارنة بمعاملة الكنترول (بدون تلقيح) في كلا الموسمين.

- أوضحت النتائج أن التفاعل بين الأصناف والتسميد الأزوتي أدى إلي تأثير معنوي في إرتفاع النباتات ومحصول الفدان بالطن في كلا الموسمين وقطر الساق ومحصول الزيت للفدان في الموسم الأول والنسبة المئوية للزيت في الموسم الثاني فقط. كما أدى التفاعل بين الأصناف والتسميد الحيوي إلي تأثير معنوي في قطر الساق ومحصول البذور والزيت للفدان في الموسم الأول والثاني وفي إرتفاع النبات وقطر القرص في الموسم الأول والنسبة المئوية للزيت في الموسم الثاني فقط. بينما أظهر التفاعل بين التسميد الأزوتي والحيوي تأثير معنوي في قطر الساق وعدد البذور بالقرص ومحصول النبات والفدان من البذور في كلا الموسمين، وإرتفاع النبات وقطر القرص ومحصول الفدان من الزيت في الموسم الأول ونسبة الزيت في الموسم الثاني فقط ، أظهر التفاعل بين الأصناف والتسميد الأزوتي والحيوي إلي حدوث تأثير معنوي في صفة قطر الساق ومحصول الفدان بالطن في الموسمين وإرتفاع النبات ومحصول الزيت للفدان في الموسم الأول فقط.

وتوصي النتائج أن أعلى إنتاجية من محصول البذور والزيت للفدان وذلك بزراعة الصنف سحا ٣٥ والتسميد بمعدل ٣٥ كجم/ن/ف وتلقيح البذور بالسيريالين.

Table 2: Effect of nitrogen levels, bio-fertilizer and their interactions on plant height (cm) and stem diameter of two sunflower cultivars during 2012 and 2013 seasons.

Sunflower cultivars (A)	Nitrogen levels (kg/fad.) (B)	Plant height (cm)								Stem diameter (cm)							
		Bio-fertilizer (C)															
		2012				2013				2012				2013			
		Cont.	Phos.	Cer.	Mean	Uninoc.	Phos.	Cer.	Mean	Cont.	Phos.	Cer.	Mean	Uninoc.	Phos.	Cer.	Mean
Sakha (53)	15	109.09	170.44	171.06	170.52	158.22	178.00	171.00	170.76	2.103	2.320	2.397	2.280	2.170	2.280	2.303	2.201
	25	173.34	174.90	178.17	172.14	163.33	174.00	177.70	171.84	2.173	2.410	2.703	2.396	2.181	2.327	2.413	2.307
	35	179.38	179.17	183.11	177.22	171.58	180.03	183.86	178.66	2.227	2.013	2.700	2.463	2.210	2.363	2.063	2.379
	Mean	174.10	173.17	177.71	171.73	174.38	174.34	177.04	172.09	2.178	2.421	2.000	2.380	2.187	2.323	2.427	2.312
Giza(102)	15	100.00	177.89	179.03	173.97	107.07	170.89	172.28	174.91	2.080	2.233	2.377	2.226	2.133	2.210	2.270	2.201
	25	171.22	172.43	174.00	172.39	171.39	170.28	173.71	178.43	2.117	2.373	2.403	2.314	2.103	2.223	2.383	2.203
	35	170.79	177.77	181.16	174.01	178.39	178.89	181.08	177.12	2.180	2.433	2.490	2.378	2.170	2.340	2.477	2.326
	Mean	170.80	172.00	175.07	172.29	172.11	171.79	175.76	174.82	2.126	2.347	2.436	2.303	2.102	2.208	2.370	2.270
Means for all nitrogen levels	15	107.00	177.17	170.00	174.70	107.39	177.90	171.70	170.33	2.092	2.287	2.381	2.203	2.102	2.240	2.282	2.226
	25	172.28	173.77	177.33	174.76	172.36	172.39	170.76	170.14	2.140	2.392	2.028	2.300	2.177	2.270	2.398	2.280
	35	177.03	177.92	182.14	175.86	179.98	179.71	182.47	177.39	2.203	2.473	2.070	2.416	2.190	2.302	2.010	2.302
	Means of bio-fertilizer(C)	172.40	172.08	177.34		172.20	173.02	177.70		2.147	2.384	2.493		2.170	2.291	2.398	

L.S.D. at (0.05)

Cultivars (A)		*		*		*		*
Nitrogen (B)	0.422			0.978		0.149		0.0086
Bio-fertilizers (C)	0.506			1.035		0.308		0.0078
A X B	0.597			1.383		0.0211		N.S
A X C	0.716			N.S		0.0178		0.0109
B X C	0.876			N.S		0.217		0.0133
A X B X C	1.239			N.S		0.0308		0.0188

Table 3: Effect of nitrogen levels, bio-fertilizer and their interactions on head diameter and Number of seed per plant of two sunflower cultivars during 2012 and 2013 seasons.

Sunflower cultivars (A)	Nitrogen levels (kg/fad.) (B)	Head diameter (cm)								Number of seed per head							
		Bio-fertilizer (C)															
		2012				2013				2012				2013			
		Cont.	Phos.	Cer.	Mean	Uninoc.	Phos.	Cer.	Mean	Cont.	Phos.	Cer.	Mean	Uninoc.	Phos.	Cer.	Mean
Sakha (53)	15	17.167	18.000	19.090	18.419	17.700	17.997	18.770	17.777	10.7087	1123.27	1174.91	1123.02	1070.70	1170.48	1200.77	1140.67
	25	17.007	19.007	20.417	19.177	17.407	19.083	20.077	18.807	10.8470	1171.41	1223.03	1109.84	1077.30	1289.03	1319.40	1224.93
	35	18.713	19.890	21.928	19.928	17.777	19.713	20.007	19.317	10.9127	1210.74	1270.83	1187.08	1079.49	1301.70	1328.94	1233.39
	Mean	17.779	19.316	20.429	19.174	17.778	18.898	19.768	18.748	10.8224	1178.44	1219.70	1107.81	1070.03	1203.70	1284.71	1201.33
Giza(102)	15	17.083	17.890	18.777	17.700	10.780	17.290	18.007	17.192	10.3038	1119.04	1142.77	1099.07	1033.98	1174.09	1192.87	1130.48
	25	17.200	19.303	19.873	18.896	17.003	18.003	19.393	18.177	10.7203	1104.14	1217.27	1144.70	1004.70	1291.47	1317.72	1220.91
	35	18.303	19.013	20.303	19.373	17.423	19.017	19.790	18.743	10.7094	1194.21	1293.22	1178.13	1070.39	1277.33	1322.00	1233.24
	Mean	17.479	18.902	19.788	18.773	17.086	18.287	19.230	18.034	10.7299	1100.80	1199.70	1137.28	1003.00	1244.47	1277.17	1191.04
Means for all nitrogen levels	15	17.870	18.190	19.183	18.084	17.210	17.743	18.088	17.482	10.0313	1121.17	1108.84	1111.04	1047.37	1177.04	1199.32	1138.08
	25	17.038	19.430	20.140	19.036	17.980	18.818	19.730	18.011	10.7306	1172.78	1220.40	1102.20	1070.00	1290.24	1318.01	1222.92
	35	18.408	19.702	20.792	19.701	17.700	19.310	20.173	19.029	10.8111	1202.43	1200.03	1177.80	1079.94	1289.04	1320.47	1238.32
	Means of bio- fertilizer(C)	17.724	19.107	20.038		17.932	18.092	19.499		10.7927	1172.12	1209.70		1009.27	1249.11	1280.93	

L.S.D. at (0.05)

Cultivars (A)	*		*	N.S
Nitrogen (B)	0.336		0.258	8.960
Bio-fertilizers (C)	0.152		0.2006	7.949
A X B	N.S		N.S	N.S
A X C	0.215		N.S	N.S
B X C	0.264		N.S	12.04
A X B X C	N.S		N.S	N.S

Table 4: Effect of nitrogen levels, bio-fertilizer and their interactions on 1000- seed weight (g) and seed weight per plant (g) of two sunflower cultivars during 2012 and 2013 seasons.

Sunflower cultivars (A)	Nitrogen levels (kg/fad.) (B)	1000- seed weight (g)								Seed weight per plant (g)							
		Bio-fertilizer (C)															
		2012				2013				2012				2013			
		Cont.	Phos.	Cer.	Mean	Uninoc.	Phos.	Cer.	Mean	Cont..	Phos.	Cer.	Mean	Uninoc.	Phos.	Cer.	Mean
Sakha (53)	15	04.943	71.100	72.100	09.348	03.733	08.940	70.110	07.714	08.943	78.077	72.900	77.807	07.020	78.987	72.000	77.187
	25	06.227	72.490	73.777	70.828	00.707	70.223	71.927	09.202	71.190	72.383	77.893	70.789	09.400	77.730	81.703	72.928
	35	08.110	74.730	70.783	72.808	07.733	72.387	73.193	71.104	73.470	78.240	82.933	74.881	71.733	81.207	82.970	70.737
Mean		06.427	72.773	72.833	71.111	00.741	70.017	71.763	09.340	71.178	73.400	77.909	70.827	09.401	70.941	79.408	71.083
Giza(102)	15	04.080	09.377	70.833	08.097	02.880	07.403	09.280	07.038	00.987	77.437	79.010	73.978	04.777	77.900	70.700	74.089
	25	04.787	71.140	72.223	09.283	04.800	09.447	71.003	08.433	08.207	70.437	70.490	78.044	07.783	77.770	80.470	71.771
	35	06.770	73.837	71.747	70.748	07.233	71.700	09.340	09.074	70.780	77.207	80.740	72.027	70.170	78.923	82.803	72.982
Mean		00.176	71.418	71.034	09.376	04.738	09.017	09.891	08.010	08.291	71.043	70.213	78.183	07.040	74.194	78.008	79.914
Means for all nitrogen levels	15	04.012	70.213	71.442	08.722	03.307	08.197	09.720	07.076	07.470	77.007	71.200	70.392	00.843	77.943	71.720	70.137
	25	00.007	71.760	72.840	70.006	00.278	09.830	71.490	08.878	09.748	71.910	77.792	79.417	08.717	77.190	81.087	72.299
	35	07.410	74.233	72.760	71.803	07.983	72.018	71.277	70.089	72.070	77.248	81.787	73.703	70.902	80.070	82.412	74.809
Means of bio-fertilizer (C)		00.826	72.071	72.784		00.189	70.017	70.827		09.729	72.222	77.071		08.471	70.078	78.708	

L.S.D. at (0.05)

Cultivars (A)	*	*	*	*
Nitrogen (B)	1.26	1.096	0.331	0.0314
Bio-fertilizers (C)	1.087	1.041	0.446	0.7103
A X B	N.S	N.S	N.S	N.S
A X C	N.S	N.S	N.S	N.S
B X C	N.S	N.S	0.772	1.007
A X B X C	N.S	N.S	N.S	N.S

Table 5: Effect of nitrogen levels, bio-fertilizer and their interactions on seed yield ton per fad. and seed oil percentage of two sunflower cultivars during 2012 and 2013 seasons.

Sunflower cultivars (A)	Nitrogen levels (kg/fad.) (B)	Seed yield (t/ fad)								Seed oil percentage							
		2012				2013				Bio-fertilizer (C) 2012				2013			
		Cont..	Phos.	Cer.	Mean	Uninoc.	Phos.	Cer.	Mean	Cont.	Phos.	Cer.	Mean	Uninoc.	Phos.	Cer.	Mean
		Sakha (53)	15	1.405	1.710	1.799	1.760	1.000	1.828	1.930	1.771	20.227	22.323	23.393	22.394	20.923	20.020
	25	1550	1.891	2.111	1.801	1.073	1.992	2.100	1.900	22.870	23.803	24.830	23.848	20.327	22.027	23.100	22.228
	35	1.653	2.017	2.192	1.902	1.778	2.101	2.190	1.990	23.720	24.723	21.783	24.723	22.223	23.210	24.803	23.019
Mean		1.037	1.872	2.032	1.810	1.080	1.981	2.090	1.880	22.723	23.707	24.723	23.728	20.228	22.179	23.223	22.200
Giza(102)	15	1.200	1.778	1.700	1.713	1.237	1.727	1.870	1.728	20.800	29.827	39.127	39.918	20.123	29.213	38.777	39.222
	25	1.027	1.813	1.880	1.721	1.292	1.882	1.982	1.787	20.220	29.120	38.297	39.217	29.777	38.723	37.703	38.098
	35	1.770	1.920	2.087	1.893	1.702	1.970	2.113	1.897	29.277	38.107	37.173	38.279	38.200	37.307	37.823	37.020
Mean		1.032	1.800	1.909	1.729	1.010	1.878	1.989	1.789	20.179	29.023	38.199	39.132	29.220	38.222	37.788	38.022
Means for all nitrogen levels	15	1.200	1.777	1.777	1.727	1.271	1.797	1.900	1.722	23.123	24.080	21.220	24.107	23.023	24.217	21.212	24.222
	25	1.038	1.802	1.998	1.797	1.032	1.939	2.077	1.827	22.020	21.287	20.023	21.032	22.002	21.220	20.020	21.213
	35	1.709	1.971	2.139	1.923	1.720	2.038	2.101	1.923	21.028	20.329	29.228	20.207	21.222	20.223	29.818	20.022
Means of bio-fertilizer (C)		1.032	1.820	1.971		1.028	1.920	2.039		22.207	21.321	20.217		22.229	21.222	20.021	

L.S.D. at (0.05)

Cultivars (A)	*		*		*	
Nitrogen (B)	0.0149		0.0086		0.219	0.1712
Bio-fertilizers (C)	0.0133		0.0077		0.132	0.102
A X B	0.0211		0.0122		N.S	0.228
A X C	0.0188		0.1088		N.S	0.122
B X C	0.0231		0.0133		N.S	0.177
A X B X C	0.0326		0.0188		N.S	N.S

Table 6: Effect of nitrogen levels, bio-fertilizer and their interactions on oil yield kg/fad. of two sunflower cultivars during 2012 and 2013 seasons.

Sunflower cultivars (A)	Nitrogen levels (kg/fad.) (B)	Oil yield (kg/fad)							
		Bio-fertilizer (C)							
		2012				2013			
		Cont.	Cer.	Phos.	Mean	Cont.	Cer.	Phos.	Mean
Sakha (53)	15	738.78	770.34	780.81	726.71	791.70	831.82	800.12	791.18
	25	790.36	829.12	904.13	809.04	712.84	881.34	927.08	840.08
	35	721.14	803.16	913.37	829.22	747.07	910.09	937.39	874.01
Mean		780.07	814.21	877.10	788.47	717.83	874.42	900.03	832.09
Giza(102)	15	073.10	778.29	787.04	742.98	076.47	788.10	720.00	773.20
	25	717.49	709.24	721.76	782.00	770.14	720.93	748.90	709.99
	35	707.31	734.73	770.81	722.08	710.17	737.77	778.17	710.33
Mean		710.73	704.00	728.37	782.79	717.27	710.08	700.79	794.01
Mean for N-levels	15	700.89	714.31	734.17	784.99	734.03	709.99	787.07	727.19
	25	700.92	779.18	812.90	747.02	787.49	801.14	838.24	770.29
	35	789.22	793.89	844.09	770.90	780.72	823.88	807.78	787.42
Means of bio-fertilizer (c)		700.30	709.13	797.24		777.04	790.00	827.87	

L.S.D. at (0.05)

Cultivars (A)
 Nitrogen (B)
 Bio-fertilizers (C)
 A X B
 A X C
 B X C
 A X B X C

*
 6.624
 6.199
 9.368
 8.767
 10.74
 15.19

*
 22.75
 20.09
 N.S
 28.42
 N.S
 N.S