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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 fallows: 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 N_2- 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 wall 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 P_2O_5 /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 aimes 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/m^2 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 m^2 (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 spilt 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 Soxalet apparatus according to **A.O.A.C. (1995).**

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

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

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 N_2- fixation bacteria (Cerealin) 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 cerealin gave the highest mean values of all studied characters. Generally, results pointed out to a beneficial effect of seed inoculation with N_2- 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 greate 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 cerealin. 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، ٢٠١٣م 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 (سخا-٥٣ وجيزة ١٠٢) وقد إستخدم 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 الاولي 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 سخا ٥٣ علي جيزة -١٠٢ في كل الصفات المدروسة مثل إرتفاع النبات وقطر الساق والقرص ووزن ال١٠٠٠ بذرة ومحصول البذور للنبات والفدان والنسبة المئوية للزيت ومحصول الزيت للفدان في كلا الموسمين.
- أشارت النتائج الي أن زيادة معدلات التسميد الازوتي من ١٥ إلي ٢٥ او٣٥ كجم ن/فدان ادت 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 السريالين إلي زيادة معنوية في إرتفاع النبات وقطر الساق والقرص وعدد البذور بالقرص ووزن ال١٠٠٠ 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 أدي 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 أدي 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 أظهرالتفاعل 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 ، أظهرالتفاعل 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 أعلي إنتاجية من محصول البذور والزيت للفدان وذلك بزراعة الصنف سخا ٥٣ 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	١٥٩.٥٩	١٦٥.٤٤	١٧١.٥٦	١٦٥.٥٣	158.22	١٦٨.٠٠	١٧١.٠٥	١٦٥.٧٦	٢.١٠٣	٢.٣٤٠	٢.٣٩٧	٢.٢٨٠	٢.١٧٠	٢.٢٨٠	٢.٣٠٣	٢.٢٥١
	25	١٦٣.٣٤	١٧٤.٩٠	١٧٨.١٧	١٧٢.١٤	163.33	١٧٤.٥٠	١٧٧.٧٠	١٧١.٨٤	٢.١٧٣	٢.٤١٠	٢.٦٠٣	٢.٣٩٦	٢.١٨١	٢.٣٢٧	٢.٤١٣	٢.٣٠٧
	35	١٦٩.٣٨	١٧٩.١٧	١٨٣.١١	١٧٧.٢٢	171.58	١٨٠.٥٣	١٨٣.٨٦	١٧٨.٦٦	٢.٢٢٧	٢.٥١٣	٢.٦٥٠	٢.٤٦٣	٢.٢١٠	٢.٣٦٣	٢.٥٦٣	٢.٣٧٩
Mean		١٦٤.١٠	١٧٣.١٧	١٧٧.٦١	١٧١.٦٣	١٦٤.٣٨	١٧٤.٣٤	١٧٧.٥٤	١٧٢.٠٩	٢.١٦٨	٢.٤٢١	٢.٥٥٠	٢.٣٨٠	٢.١٨٧	٢.٣٢٣	٢.٤٢٧	٢.٣١٢
Giza(102)	15	١٥٥.٥٠	١٦٦.٨٩	١٦٩.٥٣	١٦٣.٩٧	١٥٦.٥٦	١٦٥.٨٩	١٧٢.٢٨	١٦٤.٩١	٢.٠٨٠	٢.٢٣٣	٢.٣٦٦	٢.٢٢٦	٢.١٣٣	٢.٢١٠	٢.٢٦٠	٢.٢٠١
	25	١٦١.٢٢	١٧٢.٤٣	١٧٤.٥٠	١٦٩.٣٩	١٦١.٣٩	١٧٠.٢٨	١٧٣.٦١	١٦٨.٤٣	٢.١١٧	٢.٣٧٣	٢.٤٥٣	٢.٣١٤	٢.١٥٣	٢.٢٢٣	٢.٣٨٣	٢.٢٥٣
	35	١٦٥.٦٩	١٧٦.٦٧	١٨١.١٦	١٧٤.٥١	١٦٨.٣٩	١٧٨.٨٩	١٨١.٠٨	١٧٦.١٢	٢.١٨٠	٢.٤٣٣	٢.٤٩٠	٢.٣٦٨	٢.١٧٠	٢.٣٤٠	٢.٤٦٧	٢.٣٢٦
Mean		١٦٠.٨٠	١٧٢.٠٠	١٧٥.٠٧	١٦٩.٢٩	١٦٢.١١	١٧١.٦٩	١٧٥.٦٦	١٦٩.٨٢	٢.١٢٦	٢.٣٤٧	٢.٤٣٦	٢.٣٠٣	٢.١٥٢	٢.٢٥٨	٢.٣٧٠	٢.٢٦٠
Means for all nitrogen levels	15	١٥٧.٥٥	١٦٦.١٧	١٧٠.٥٥	١٦٤.٧٥	١٥٧.٣٩	١٦٦.٩٥	١٧١.٦٥	١٦٥.٣٣	٢.٠٩٢	٢.٢٨٧	٢.٣٨١	٢.٢٥٣	٢.١٥٢	٢.٢٤٥	٢.٢٨٢	٢.٢٢٦
	25	١٦٢.٢٨	١٧٣.٦٧	١٧٦.٣٣	١٧٠.٧٦	١٦٢.٣٦	١٧٢.٣٩	١٧٥.٦٦	١٧٠.١٤	٢.١٤٥	٢.٣٩٢	٢.٥٢٨	٢.٣٥٥	٢.١٦٧	٢.٢٧٥	٢.٣٩٨	٢.٢٨٠
	35	١٦٧.٥٣	١٧٧.٩٢	١٨٢.١٤	١٧٥.٨٦	١٦٩.٩٨	١٧٩.٧١	١٨٢.٤٧	١٧٧.٣٩	٢.٢٠٣	٢.٤٧٣	٢.٥٧٠	٢.٤١٦	٢.١٩٠	٢.٣٥٢	٢.٥١٥	٢.٣٥٢
Means of bio-fertilizer(C)		١٦٢.٤٥	١٧٢.٥٨	١٧٦.٣٤		١٦٣.٢٥	١٧٣.٠٢	١٧٦.٦٠		٢.١٤٧	٢.٣٨٤	٢.٤٩٣		٢.١٧٠	٢.٢٩١	٢.٣٩٨	

L.S.D. at (0.05)

Cultivars (A)	*	*	*	*
Nitrogen (B)	0.422	0.978	٠.٠١٤٩	٠.٠٠٨٦
Bio-fertilizers (C)	0.506	1.035	٠.٠٣٠٨	٠.٠٠٧٨
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	٠.٠٢١٧	٠.٠١٣٣
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	١٧.١٦٧	١٨.٥٠٠	١٩.٥٩٠	١٨.٤١٩	١٦.٦٥٠	١٧.٩٩٧	١٨.٦٧٠	١٧.٧٧٢	١٠٧٠.٨٧	١١٢٣.٢٧	١١٧٤.٩١	١١٢٣.٠٢	١٠٦٠.٧٥	١١٧٠.٤٨	١٢٠٥.٧٧	١١٤٥.٦٧
	25	١٧.٥٥٧	١٩.٥٥٧	٢٠.٤١٧	١٩.١٧٧	١٧.٤٠٧	١٩.٠٨٣	٢٠.٠٧٧	١٨.٨٥٦	١٠٨٤.٦٠	١١٧١.٤١	١٢٢٣.٥٣	١١٥٩.٨٤	١٠٦٦.٣٥	١٢٨٩.٠٣	١٣١٩.٤٠	١٢٢٤.٩٣
	35	١٨.٦١٣	١٩.٨٩٠	٢١.٩٢٨	١٩.٩٢٨	١٧.٧٧٧	١٩.٦١٣	٢٠.٥٥٧	١٩.٣١٦	١٠٩١.٢٧	١٢١٠.٦٤	١٢٦٠.٨٣	١١٨٧.٥٨	١٠٦٩.٤٩	١٣٠١.٧٥	١٣٢٨.٩٤	١٢٣٣.٣٩
Mean		١٧.٧٧٩	١٩.٣١٦	٢٠.٤٢٩	١٩.١٧٤	١٧.٢٧٨	١٨.٨٩٨	١٩.٧٦٨	١٨.٦٤٨	١٠٨٢.٢٤	١١٦٨.٤٤	١٢١٩.٧٥	١١٥٦.٨١	١٠٦٥.٥٣	١٢٥٣.٧٥	١٢٨٤.٧١	١٢٠١.٣٣
Giza(102)	15	١٦.٥٨٣	١٧.٨٩٠	١٨.٧٧٧	١٧.٧٥٠	١٥.٧٨٠	١٧.٢٩٠	١٨.٥٠٧	١٧.١٩٢	١٠٣٥.٣٨	١١١٩.٠٤	١١٤٢.٧٧	١٠٩٩.٠٧	١٠٣٣.٩٨	١١٦٤.٥٩	١١٩٢.٨٧	١١٣٠.٤٨
	25	١٧.٢٥٠	١٩.٣٠٣	١٩.٨٦٣	١٨.٨٩٦	١٦.٥٥٣	١٨.٥٥٣	١٩.٣٩٣	١٨.١٦٧	١٠٦٢.٥٣	١١٥٤.١٤	١٢١٧.٢٧	١١٤٤.٦٥	١٠٥٤.٦٥	١٢٩١.٤٦	١٣١٦.٦٢	١٢٢٠.٩١
	35	١٨.٣٠٣	١٩.٥١٣	٢٠.٣٠٣	١٩.٣٧٣	١٧.٤٢٣	١٩.٠١٧	١٩.٧٩٠	١٨.٧٤٣	١٠٧٠.٩٤	١١٩٤.٢١	١٢٩٣.٢٢	١١٦٨.١٣	١٠٧٠.٣٩	١٢٧٧.٣٣	١٣٢٢.٠٠	١٢٢٣.٢٤
Mean		١٧.٤٦٩	١٨.٩٠٢	١٩.٦٤٨	١٨.٦٧٣	١٦.٥٨٦	١٨.٢٨٧	١٩.٢٣٠	١٨.٠٣٤	١٠٥٦.٢٩	١١٥٥.٨٠	١١٩٩.٧٥	١١٣٧.٢٨	١٠٥٣.٠٠	١٢٤٤.٤٦	١٢٧٧.١٦	١١٩١.٥٤
Means for all nitrogen levels	15	١٦.٨٧٥	١٨.١٩٥	١٩.١٨٣	١٨.٠٨٤	١٦.٢١٥	١٧.٦٤٣	١٨.٥٨٨	١٧.٤٨٢	١٠٥٣.١٣	١١٢١.١٦	١١٥٨.٨٤	١١١١.٠٤	١٠٤٧.٣٧	١١٦٧.٥٤	١١٩٩.٣٢	١١٣٨.٠٨
	25	١٧.٥٣٨	١٩.٤٣٠	٢٠.١٤٠	١٩.٠٣٦	١٦.٩٨٠	١٨.٨١٨	١٩.٧٣٥	١٨.٥١١	١٠٧٣.٥٦	١١٦٢.٧٨	١٢٢٠.٤٠	١١٥٢.٢٥	١٠٦٠.٥٠	١٢٩٠.٢٤	١٣١٨.٠١	١٢٢٢.٩٢
	35	١٨.٤٥٨	١٩.٧٠٢	٢٠.٧٩٢	١٩.٦٥١	١٧.٦٠٠	١٩.٣١٥	٢٠.١٧٣	١٩.٠٢٩	١٠٨١.١١	١٢٠٢.٤٣	١٢٥٠.٠٣	١١٧٧.٨٥	١٠٦٩.٩٤	١٢٨٩.٥٤	١٣٢٥.٤٧	١٢٢٨.٣٢
Means of bio- fertilizer(C)		١٧.٦٢٤	١٩.١٠٦	٢٠.٠٣٨		١٦.٩٣٢	١٨.٥٩٢	١٩.٤٩٩		١٠٦٩.٢٧	١١٦٢.١٢	١٢٠٩.٧٥		١٠٥٩.٢٧	١٢٤٩.١١	١٢٨٠.٩٣	

L.S.D. at (0.05)				
Cultivars (A)	*	*	N.S	N.S
Nitrogen (B)	0.336	0.258	٩.٠٠٩	٨.٩٦٠
Bio-fertilizers (C)	0.152	0.2006	٦.٩٤٩	١٢.٦٥
A X B	N.S	N.S	N.S	N.S
A X C	0.215	N.S	N.S	N.S
B X C	0.264	N.S	١٢.٠٤	٢١.٩١
A X B X C	N.S	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	٥٤.٩٤٣	٦١.٠٥٠	٦٢.٠٥٠	٥٩.٣٤٨	٥٣.٧٣٣	٥٨.٩٤٠	٦٠.١٧٠	٥٧.٦١٤	٥٨.٩٤٣	٦٨.٥٧٧	٧٢.٩٠٠	٦٦.٨٠٧	٥٧.٠٢٠	٦٨.٩٨٧	٧٢.٥٥٠	٦٦.١٨٦
	25	٥٦.٣٢٧	٦٢.٤٩٠	٦٣.٦٦٧	٦٠.٨٢٨	٥٥.٧٥٧	٦٠.٢٢٣	٦١.٩٢٧	٥٩.٣٠٢	٦١.٠٩٠	٧٣.٣٨٣	٧٧.٨٩٣	٧٠.٧٨٩	٥٩.٤٥٠	٧٧.٦٣٠	٨١.٧٠٣	٧٢.٩٢٨
	35	٥٨.١٦٠	٦٤.٦٣٠	٦٥.٧٨٣	٦٢.٨٥٨	٥٧.٧٣٣	٦٢.٣٨٧	٦٣.١٩٣	٦١.١٠٤	٦٣.٤٧٠	٧٨.٢٤٠	٨٢.٩٣٣	٧٤.٨٨١	٦١.٧٣٣	٨١.٢٠٧	٨٣.٩٧٠	٧٥.٦٣٧
Mean		٥٦.٤٧٧	٦٢.٧٢٣	٦٣.٨٣٣	٦١.٠١١	٥٥.٧٤١	٦٠.٥١٧	٦١.٧٦٣	٥٩.٣٤٠	٦١.١٦٨	٧٣.٤٠٠	٧٧.٩٠٩	٧٠.٨٢٦	٥٩.٤٠١	٧٥.٩٤١	٧٩.٤٠٨	٧١.٥٨٣
Giza(102)	15	٥٤.٠٨٠	٥٩.٣٧٧	٦٠.٨٣٣	٥٨.٠٩٧	٥٢.٨٨٠	٥٧.٤٥٣	٥٩.٢٨٠	٥٦.٥٣٨	٥٥.٩٨٧	٦٦.٤٣٧	٦٩.٥١٠	٦٣.٩٧٨	٥٤.٦٦٧	٦٦.٩٠٠	٧٠.٧٠٠	٦٤.٠٨٩
	25	٥٤.٧٨٧	٦١.٠٤٠	٦٢.٠٢٣	٥٩.٢٨٣	٥٤.٨٠٠	٥٩.٤٤٧	٦١.٠٥٣	٥٨.٤٣٣	٥٨.٢٠٧	٧٠.٤٣٧	٧٥.٤٩٠	٦٨.٠٤٤	٥٧.٧٨٣	٧٦.٧٦٠	٨٠.٤٧٠	٧١.٦٧١
	35	٥٦.٦٦٠	٦٣.٨٣٧	٦١.٧٤٧	٦٠.٧٤٨	٥٦.٢٣٣	٦١.٦٥٠	٥٩.٣٤٠	٥٩.٠٧٤	٦٠.٦٨٠	٧٦.٢٥٧	٨٠.٦٤٠	٧٢.٥٢٦	٦٠.١٧٠	٧٨.٩٢٣	٨٢.٨٥٣	٧٣.٩٨٢
Mean		٥٥.١٧٦	٦١.٤١٨	٦١.٥٣٤	٥٩.٣٧٦	٥٤.٦٣٨	٥٩.٥١٧	٥٩.٨٩١	٥٨.٠١٥	٥٨.٢٩١	٧١.٠٤٣	٧٥.٢١٣	٦٨.١٨٣	٥٧.٥٤٠	٧٤.١٩٤	٧٨.٠٠٨	٦٩.٩١٤
Means for all nitrogen levels	15	٥٤.٥١٢	٦٠.٢١٣	٦١.٤٤٢	٥٨.٧٢٢	٥٣.٣٠٧	٥٨.١٩٧	٥٩.٧٢٥	٥٧.٠٧٦	٥٧.٤٦٥	٦٧.٥٠٧	٧١.٢٠٥	٦٥.٣٩٢	٥٥.٨٤٣	٦٧.٩٤٣	٧١.٦٢٥	٦٥.١٣٧
	25	٥٥.٥٥٧	٦١.٧٦٥	٦٢.٨٤٥	٦٠.٠٥٦	٥٥.٢٧٨	٥٩.٨٣٥	٦١.٤٩٠	٥٨.٨٦٨	٥٩.٦٤٨	٧١.٩١٠	٧٦.٦٩٢	٦٩.٤١٧	٥٨.٦١٧	٧٧.١٩٥	٨١.٠٨٧	٧٢.٢٩٩
	35	٥٧.٤١٠	٦٤.٢٣٣	٦٣.٧٦٥	٦١.٨٠٣	٥٦.٩٨٣	٦٢.٠١٨	٦١.٢٦٧	٦٠.٠٨٩	٦٢.٠٧٥	٧٧.٢٤٨	٨١.٧٨٧	٧٣.٧٠٣	٦٠.٩٥٢	٨٠.٠٦٥	٨٣.٤١٢	٧٤.٨٠٩
Means of bio-fertilizer (C)		٥٥.٨٢٦	٦٢.٠٧١	٦٢.٦٨٤		٥٥.١٨٩	٦٠.٠١٧	٦٠.٨٢٧		٥٩.٧٢٩	٧٢.٢٢٢	٧٦.٥٦١		٥٨.٤٧١	٧٥.٠٦٨	٧٨.٧٠٨	
L.S.D. at (0.05)																	
Cultivars (A)				*				*				*				*	
Nitrogen (B)				1.26				1.096				٠.٣٣١				٠.٥٣١٤	
Bio-fertilizers (C)				1.087				1.041				٠.٤٤٦				٠.٦١٠٣	
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				٠.٧٧٢				١.٠٥٧	
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							
		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	1.405	١.٧١٥	١.٧٩٩	١.٦٤٠	١.٥٠٥	١.٨٤٨	١.٩٣٠	١.٧٦١	٤٥.٤٤٧	٤٤.٣٤٣	٤٣.٣٩٣	٤٤.٣٩٤	٤٥.٩٤٣	٤٥.٠٢٠	٤٤.٠٤٧	٤٥.٠٠٣
	25	1550	١.٨٩١	٢.١١١	١.٨٥١	١٥٧٣	١.٩٩٤	٢.١٥٠	١.٩٠٥	٤٤.٨٦٠	٤٣.٨٥٣	٤٢.٨٣٠	٤٣.٨٤٨	٤٥.٣٢٧	٤٤.٢٠٧	٤٣.١٥٠	٤٤.٢٢٨
	35	1.653	٢.٠١٦	٢.١٩٢	١.٩٥٤	١.٦٧٨	٢.١٠١	٢.١٩٠	١.٩٩٠	٤٣.٦٢٠	٤٢.٦٢٣	٤١.٦٨٣	٤٢.٦٤٢	٤٤.٤٤٣	٤٣.٣١٠	٤٢.٨٠٣	٤٣.٥١٩
Mean		١.٥٣٦	١.٨٧٤	٢.٠٣٤	١.٨١٥	١.٥٨٥	١.٩٨١	٢.٠٩٠	١.٨٨٥	٤٤.٦٤٢	٤٣.٦٠٧	٤٢.٦٣٦	٤٣.٦٢٨	٤٥.٢٣٨	٤٤.١٧٩	٤٣.٣٣٣	٤٤.٢٥٠
Giza(102)	15	١.٤٠٥	١.٦٧٨	١.٧٥٥	١.٦١٣	١.٤٣٦	١.٧٤٦	١.٨٧٠	١.٦٨٤	٤٠.٨٠٠	٣٩.٨٢٧	٣٩.١٢٧	٣٩.٩١٨	٤٠.١٤٣	٣٩.٤١٣	٣٨.٧٧٧	٣٩.٤٤٤
	25	١.٥٢٦	١.٨١٣	١.٨٨٥	١.٧٤١	١.٤٩٢	١.٨٨٤	١.٩٨٤	١.٧٨٧	٤٠.٢٣٠	٣٩.١٢٠	٣٨.٢٩٧	٣٩.٢١٦	٣٩.٧٧٧	٣٨.٢٦٣	٣٧.٧٥٣	٣٨.٥٩٨
	35	١.٦٦٥	١.٩٢٥	٢.٠٨٧	١.٨٩٣	١.٦٠٢	١.٩٧٥	٢.١١٣	١.٨٩٦	٣٩.٤٧٧	٣٨.١٥٧	٣٧.١٧٣	٣٨.٢٦٩	٣٨.٤٠٠	٣٧.٣٥٧	٣٦.٨٣٣	٣٧.٥٣٠
Mean		١.٥٣٢	١.٨٠٥	١.٩٠٩	١.٧٤٩	١.٥١٠	١.٨٦٨	١.٩٨٩	١.٧٨٩	٤٠.١٦٩	٣٩.٠٤٣	٣٨.١٩٩	٣٩.١٣٤	٣٩.٤٤٠	٣٨.٣٤٤	٣٧.٧٨٨	٣٨.٥٢٤
Means for all nitrogen levels	15	١.٤٠٥	١.٦٩٦	١.٧٧٧	١.٦٢٦	١.٤٧١	١.٧٩٧	١.٩٠٠	١.٧٢٢	٤٣.١٢٣	٤٢.٠٨٥	٤١.٢٦٠	٤٢.١٥٦	٤٣.٠٤٣	٤٢.٢١٧	٤١.٤١٢	٤٢.٢٢٤
	25	١.٥٣٨	١.٨٥٢	١.٩٩٨	١.٧٩٦	١.٥٣٢	١.٩٣٩	٢.٠٦٧	١.٨٤٦	٤٢.٥٤٥	٤١.٤٨٧	٤٠.٥٦٣	٤١.٥٣٢	٤٢.٥٥٢	٤١.٢٣٥	٤٠.٤٥٢	٤١.٤١٣
	35	١.٦٥٩	١.٩٧١	٢.١٣٩	١.٩٢٣	١.٦٤٠	٢.٠٣٨	٢.١٥١	١.٩٤٣	٤١.٥٤٨	٤٠.٣٩٠	٣٩.٤٢٨	٤٠.٤٥٦	٤١.٤٢٢	٤٠.٣٣٣	٣٩.٨١٨	٤٠.٥٢٤
Means of bio-fertilizer (C)		١.٥٣٤	١.٨٤٠	١.٩٧١		١.٥٤٨	١.٩٢٥	٢.٠٣٩		٤٢.٤٠٦	٤١.٣٢١	٤٠.٤١٧		٤٢.٣٣٩	٤١.٢٦٢	٤٠.٥٦١	

L.S.D. at (0.05)

Cultivars (A)	*	*	*	*
Nitrogen (B)	**0.0149**	**0.0086**	٠.٢١٩	٠.١٦١٢
Bio-fertilizers (C)	**0.0133**	**0.0077**	٠.١٣٤	٠.١٠٢
A X B	**0.0211**	**0.0122**	**N.S**	٠.٢٢٨
A X C	**0.0188**	**0.1088**	**N.S**	٠.١٤٤
B X C	**0.0231**	**0.0133**	**N.S**	٠.٧٦٧
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	٦٣٨.٦٨	٧٦٠.٣٤	٧٨٠.٨١	٧٢٦.٦١	٦٩١.٦٠	٨٣١.٨٢	٨٥٠.١٢	٧٩١.١٨
	25	٦٩٥.٣٦	٨٢٩.١٢	٩٠٤.١٣	٨٠٩.٥٤	٧١٢.٨٤	٨٨١.٣٤	٩٢٧.٥٨	٨٤٠.٥٨
	35	٧٢١.١٤	٨٥٣.١٦	٩١٣.٣٧	٨٢٩.٢٢	٧٤٦.٠٦	٩١٠.٠٩	٩٣٧.٣٩	٨٦٤.٥١
Mean		٦٨٥.٠٦	٨١٤.٢١	٨٦٦.١٠	٧٨٨.٤٦	٧١٦.٨٣	٨٧٤.٤٢	٩٠٥.٠٣	٨٣٢.٠٩
Giza(102)	15	٥٧٣.١٠	٦٦٨.٢٩	٦٨٧.٥٤	٦٤٢.٩٨	٥٧٦.٤٦	٦٨٨.١٥	٧٢٥.٠٠	٦٦٣.٢٠
	25	٦١٦.٤٩	٧٠٩.٢٤	٧٢١.٧٦	٦٨٢.٥٠	٦٦٠.١٤	٧٢٠.٩٣	٧٤٨.٩٠	٧٠٩.٩٩
	35	٦٥٧.٣١	٧٣٤.٦٣	٧٧٥.٨١	٧٢٢.٥٨	٦١٥.١٧	٧٣٧.٦٦	٧٧٨.١٧	٧١٠.٣٣
Mean		٦١٥.٦٣	٧٠٤.٠٥	٧٢٨.٣٧	٦٨٢.٦٩	٦١٧.٢٦	٧١٥.٥٨	٩٥٠.٦٩	٦٩٤.٥١
Mean for N-levels	15	٦٠٥.٨٩	٧١٤.٣١	٧٣٤.١٧	٦٨٤.٧٩	٦٣٤.٠٣	٧٥٩.٩٩	٧٨٧.٥٦	٧٢٧.١٩
	25	٦٥٥.٩٢	٧٦٩.١٨	٨١٢.٩٥	٧٤٦.٠٢	٦٨٦.٤٩	٨٠١.١٤	٨٣٨.٢٤	٧٧٥.٢٩
	35	٦٨٩.٢٢	٧٩٣.٨٩	٨٤٤.٥٩	٧٧٥.٩٠	٦٨٠.٦٢	٨٢٣.٨٨	٨٥٧.٧٨	٧٨٧.٤٢
Means of bio-fertilizer (c)		٦٥٠.٣٥	٧٥٩.١٣	٧٩٧.٢٤		٦٦٧.٠٤	٧٩٥.٠٠	٨٢٧.٨٦	

L.S.D. at (0.05)

Cultivars (A)	*	*
Nitrogen (B)	**6.624**	**22.75**
Bio-fertilizers (C)	**6.199**	**20.09**
A X B	**9.368**	**N.S**
A X C	**8.767**	**28.42**
B X C	**10.74**	**N.S**
A X B X C	**15.19**	**N.S**