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Effect of Irrigation Intervals, Biological, Organic and Mineral Fertilization on the Yield and Yield Components of Sunflower Plants

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TWO FIELD experiments were carried out at the experimental farm of the Faculty of Agriculture, Saba Basha, Alexandria University, during 2007 and 2008 seasons to investigate the effect of irrigation intervals, organic manure and nitrogen biofertilization on the yield and its components of sunflower crop. Irrigation treatments were every one week, two weeks and three weeks, respectively. The fertilization treatments were 60 kg N/fed – chicken manure at rate of 8 ton/fed –commercial product contain Azospirillum, Azotobacter, Kebsiella and *Bacillus* sp. –and 30 kg N/fed. The resuits indicated that irrigation every two weeks had the highest values for all the studied characters. The fourth treatment (30kg N/fed) had significant effect on all the studied characters in both seasons. The results suggest that irrigation every two weeks and application of 30 kg N/fed could be recommended for maximum yield of sunflower under similar conditions.

Keywords: Sunflower, Chicken manure, Biofertilizer.

Sunflower (*Helianthus annuus* L.) is one of the most important oil crops in the world. In Egypt, due to the severe shortage of edible oil, sunflower received a greet attention at present time where Egypt is importing about 4/5 of the annual requirements of the edible vegetable oils. Recently, sunflower is increasingly becoming an important source of edible vegetable oil all over the world due to its high content of unsaturated fatty acids (Leland, 1996), sunflower oil is among the healthiest vegetable oils available since it ranks high in percentage of poly unsaturated acids, which can be beneficial in lowering cholesterol levels in the blood. This oil is an excellent source of linoleic acid, an essential fatty acid needed to the human body (Hui, 1996). Moreover, Sunflower receives considerable attention in Egypt due to its short growing season that is needed to fulfill the present gap between oil production and consumption. The productivity of sunflower is greatly influenced by the environmental conditions, soil fertility, and irrigation regimes. Irrigation has always played the greatest role in crop production that determines the nutrients available for the growth of the plants and ultimately crop yield. Sunflower becomes a good example with regard to moderate water requirements. The recommended intervals between successive irrigations in Egypt are about 15 days (Radwan, 1996). In recent years, biofertilizer have emerged as a promising component of integrating nutrient supply system in agriculture. Microbiological fertilizers are an impotant part of environment sustainable agricultural practices. On the other hand, organic matter

is a source and sink of plant nutrients in soil, and is important maintaining soil fertility and improving aeration and infiltration of water and consequently promoting water retention, reducing erosion, and controlling the efficiency and fate of applied pesticides. In addition, organic matter improved water holding capacity in soil which leading to more efficient utilization of inorganic phosphorus fertilizer.

This investigation was carried out to study the effect of irrigation intervals, mineral, organic and biofertilization on yield and seed quality components of sunflower under field conditions.

Materials and Methods

Two field experiments were carried out in the farm of the Faculty of Agriculture, Saba Basha, Alexandria University during the summer season of 2007 and 2008. Soil characteristics of the experimental site are shown in Table 1.

TABLE 1. Soil characteristics of the experimental site.

Sand %	Silt (%)	Clay (%)	Soil texture	pH	E.C. dS/m	O.M %	$CaCO_3$ %	Total N %	P, ppm
38	19.5	42.5	Clay	7.9	2.3	0.75	7.44	0.08	7.25

The experimental design was split plot with four replicates and the treatment were: three irrigation intervals were allocated in the main plots 1^{st}, 2^{nd}, and 3^{rd} irrigation treatments were every one week, two weeks and three weeks, respectively. The sub plots were assigned to four fertilization treatments 60 kg N/fed–chicken manure at rate of 8 ton/fed commercial product contain Azospirillum, Azotobacter, Kebsiella, and *Bacillus* sp. – and 30 kg N/fed., Each sub plot consisted of 5 ridges each 3.5m in length and 60 cm in width with 20 cm between hills contributing plot size of 10.5 m^2, *i.e.* 1/400 fed. Seeds of sunflower hybrid (VIDOC) were sown during 15 May in both seasons. The nitrogen fertilizer was used in the form of urea 46.5% N and was applied at two doses, the first dose after thinning at 30 May and the second before the first irrigation during 15 June, phosphorus fertilizer in the form of calcium superphosphate 15.5% P_2O_5 at the rate of 100 kg/fed and chicken manure were applied during the preparation of the soil. Biofertilizer is a commercial multi strain produced by the general organization for agricultural equalization fund, Ministry of Agriculture and is consisted of a mixture of P dissolving and N fixing bacteria (Azospirillum, Azotobacter, Kebsiella, and *Bacillus* sp.) was applied at sowing. Irrigation treatments were adopted at 15 June. Chemical composition of the organic matter are shown in Table 2.

TABLE 2. Chemical composition of the organic matter (chicken manure).

O.C. %	C/N ratio	Organic matter (%)	Total N (%)	P ppm	K ppm	pH	E.C. dS/m
29.35	14.1:1	51.5	2.15	124	115	7.45	2.6

At harvest, plants were taken at random from the inner area of each experimental plot to estimate the following characters:

1-Plant height (cm)
2-Stem diameter (cm)
3-Number of leaves/plant
4-Leaf area index (LAI) calculated according to Watson (1952)
5-Head diameter (cm)
6-Seed yield/plant (gm), weight of seed/head (gm)
7- seed index
8-Seed yield/fed (kg)
9-Stove yield/fed
10-Biological yield/fed (the total weight of the dry matter of sunflower plants/ fed)
11-Harvest index
12-Oil yield/fed (kg) was determined by multiplying seed yield (kg/fed) by seed oil percentage.

Seed quality

1-Seed oil percentage was determined using soxhlet apparatus according to A.O.A.C (1980).
2-Protein content: total nitrogen was determined using micro method described by Egan *et al.* (1981), protein content was calculated as N*6.25.
3-Iodine value of the oil was determined using ABBE-refractometer instrument at 20 °C. The data were subjected to the analysis of variance for split plot design according to Gomez & Gomez (1984).

Results and Discussions

Effect of irrigation intervals

The results presented in Table 3 indicated that there was a significant effect due to the irrigation intervals where the irrigation every 2 weeks gave the highest mean values of plant height, stem diameter, number of leaves/plant and LAI. The same tendency was observed regarding seed weight, 100 seed weight, seed yield /plant, seed yield/fed and stove yield/fed compared with the other two irrigation treatments, this may be due to the water irrigation supply every 2 weeks which gave the plants its requirements of water where water supply lead to the increase of total dry weight per plant and head weight as a result of increasing LA and metabolism process while insufficient water can be deleterious for the yield and maturity, these results are in agreement with those obtained by Abdel- Gawad *et al.* (1987) and Gad El-Rab *et al.* (1993).

TABLE 3. Effect of irrigation intervals, organic manure and nitrogen biofertilization on growth parameters and yield characters of sunflower plants (combined analysis of the two seasons).

Treatments	Plant height (cm)	Stem diameter (cm)	No.of leaves/ plant	Leaf area index (LAI)	Head diameter (cm)	Seed yield/ plant (gm)	Seed index (gm)	Seed yield/fed (kg)	Stove yield (ton/fed)	Harvest index (H.I.)	Biological yield (ton/fed)
	Irrigation intervals (I)										
Every 1 week	134.31 b	2.15 b	18.91 b	2.39 a	18.09 b	87.00 b	5.40 b	1220.00 b	5.87 b	17.00 a	6.99 b
Every 2 week	139.50 a	2.34 a	19.72 a	2.44 a	19.34 a	90.93 a	5.77 a	1275.13 a	6.08 a	17.00 a	7.27 a
Every 3 week	117.72 c	2.05 b	17.06 c	1.63 b	16.59 c	54.20 c	4.40 c	759.94 c	4.51 c	14.02 b	5.17 c
	Fertilization (F)										
Control	137.33 b	2.28 b	19.12 b	2.07 c	17.77 d	78.78 c	5.04 c	1108.17 d	5.61 b	15.90 c	6.58 d
Chicken manure	136.67 c	2.30 b	19.04 b	2.36 b	19.30 b	82.75 b	5.64 b	1156.75 b	5.89 a	16.03 c	6.94 b
Rhizobacterien	126.79 d	2.16 c	18.71 c	2.15 c	18.94 c	79.59 c	5.37 b	1110.67 c	5.49 c	16.77 b	6.70 c
Rhizobacterien + 30 kg N/fed	145.08 a	2.34 a	20.96 a	3.04 a	20.80 a	101.94 a	6.43 a	1431.58 a	6.01 a	18.79 a	7.31 a
	Interaction										
I*F	*	N.S.	N.S.	*	*	*	*	*	*	N.S.	N.S.

N.B.
Letters means significance compare
means result is significant
N.S. means non significant results

Data presented in Table 4 indicated that the oil yield per feddan was significantly affected by irrigation intervals where irrigation every 2 weeks gave the highest mean values of oil yield/fed and seed oil content, the results are parallel with those obtained by Chanirar *et al.* (1989) and El-Sabbagh (2003). On the other hand, Raja & Bishnoi (1988) found that oil content was not affected by irrigation intervals.

TABLE 4. Effect of irrigation intervals, organic manure and nitrogen biofertilization on chemical analysis of seed yield of sunflower plants (combined analysis of the two seasons).

Treatments	Oil yield/fed (kg)	Seed oil (%)	Seed protein (%)	Iodine value	Refractive index
	Irrigation intervals (I)				
Every 1 week	472.67 c	38.81 c	23.01 a	136.14 b	1.4736 b
Every 2 week	514.05 a	40.45 a	23.90 a	130.02 c	1.4729 c
Every 3 week	290.16 b	39.04 b	23.85 a	139.28 a	1.4740 a
	Fertilization (F)				
Control	432.90 d	39.03 a	24.80 a	136.66 a	1.4736 a
Chicken manure	444.14 c	38.92 a	24.25 a	134.34 c	1.4735 ab
Rhizobacterien	451.75 b	40.03 a	24.15 a	134.54 bc	1.4734 c
Rhizobacterien + 30 kg N/fed.	540.75 a	39.28 a	24.90 a	135.80 ab	1.4737 a
	Interaction				
I*F	N.S	N.S.	N.S.	N.S.	N.S.

N.B.
Letters means significance compare
* means result is significant
N.S. means non significant results

The data show also that irrigation interval every 3 weeks gave the highest iodine and refractive index compared to the other irrigation intervals. The results are similar with those obtained by Ali (1990). Sunflower seed content of protein was 23 %, no significant increase was found in protein content due to irrigation intervals .

Effect of fertilization

It can be observed from the collected data (Table 3) that the application of combined treatment inoculation (30 kg N/fed) gave the highest mean values of all studied characters compared with control (60 kg N/fed), it could be concluded that N-biofertilizer treatment promote the production of sunflower plants and the roots at seed germination and are colonized by N fixing bacteria energetic pathways such as glycolysis and conversion of IAA to active IAA are stimulated also the nitrogen fixing bacteria which may increase the synthesis of the endogenous phytohormones indole acetic acid, gibberellic acid and cytokinene which play an important role in formation of bioactive root system that allow more nutrients uptake and therefore may promote photosynthesis and translocation as well as accumulation of dry matter within different plants and hence increased the head weight and seed yield. Similar results were obtained by El-Khawas (1990) and Mohamed (2003).

On the other hand, the organic manure fertilizer had significant effect at all studied characters compared with control (60 kg N/fed) for example, chicken manure that conserving adequate moisture for plant growth and supplying plants with nutrients, therefore the availability of water and nutrients which causes plant's growth increas. The results are in agreement with those obtained by El-Maghraby (1997) and El-Afendy *et al.* (2000) but plant height and harvest index didn't significantly affected. Similar results were obtained by Osman & Goude (1996)

The results in Table 4 indicated that the inoculated seeds of sunflower by the biofertilizer (30 kg N/fed) gave the highest values compared with control inoculated seeds with Rhizobacteria without mineral N. Such results were supported by Bassal (2003); but Mohamed (2003) showed that sunflower seed oil content and protein content were not significantly affected by adding mineral N or biofertilization or organic manure. However, applying mineral N and biofertilization gave significant increase in iodine value and refractive index gave the highest values. Similar results were obtained by Radwan (1996), Sherif (2002) and Bassal (2003).

Effect of interactions

Data in Table 5 showed that the studied characters were significantly increased when plants were grown under seed inoculation with 30 kg N/fed and irrigation every 2 weeks, this treatment was the best treatment and the significant increase in all the studied characters may be due to the effect of N which was produced by the bacteria species in addition of some growth regulators like IAA and GA which stimulated growth of sunflower plants.

Also, the solubilization of mineral nutrients, synthesis of vitamins, amino acids, auxins and gibberellins which stimulated the growth of sunflower plants comes as result of inoculation .

However, chicken manure gave comparable results of plant height, head diameter, 100 seed weight, seed yield/plant, seed yield/fed, stove yield/fed, LAI with under irrigation every 2 weeks, these results are similar with that obtained by Nawar (1994) and Sherif (2002).

Conclusion

From the previous discussion and results obtained we can conclude that 30 kg N/fed of Rhizobacterien and chicken manure significantly increases nutrient uptake and improve plant growth, yield and its components. Also, irrigation every 2 weeks gave higher growth and yield compared with irrigation every 1 and 3 weeks.

TABLE 5. Effect of interaction between irrigation intervals and fertilization on growth and yield characters of sunflower plants.

Treatments		Plant height (cm)	Head diameter (cm)	Leaf area index (LAI)	Seed index (gm)	Seed yield/plant (gm)	Seed yield kg/fed	Stove yield (ton/fed)
Irrigation	Fertilization							
Every 1 week	Control	150.8	19.7	2.36	5.67	90.67	1249.75	6.62
	Chicken manure	134.80	19.04	2.50	4.61	89.72	1269.5	6.37
	Rhizobacterien	140.00	18.52	2.44	3.71	44.25	1317.75	6.44
	Rhizobacterien + 30 kg N/fed	135.80	20.72	3.31	4.67	91.07	1600.25	6.64
Every 2 week	Control	150.5	19.85	2.22	5.59	100.0	1356.5	6.77
	Chicken manure	142.5	19.62	2.54	5.7	105.45	1357.75	6.87
	Rhizobacterien	141.80	17.22	2.32	5.12	92.80	1351.0	6.83
	Rhizobacterien + 30 kg N/fed	166.5	21.65	3.73	6.06	114.25	1821.5	7.65
Every 3 week	Control	126.5	18.42	1.62	5.64	102.27	749.75	5.02
	Chicken manure	121.8	19.05	1.76	5.42	96.61	788.5	4.97
	Rhizobacterien	117.5	16.67	1.68	3.35	89.0	765.5	4.76
	Rhizobacterien + 30 kg N/fed	139.5	21.15	2.22	4.65	96.97	1239.75	5.50
LSD 0.05		3.01	0.95	0.2	0.70	4.53	4.57	0.17

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تاثير فترات الرى و التاثير المشترك بين التسميد الحيوى والعضوى والمعدنى على محصول عباد الشمس ومكوناته

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اجريت تجربة حقلية خلال الموسمين الصيفيين ٢٠٠٧ و ٢٠٠٨ بمزرعة كلية الزراعة- سابا باشا – الاسكندرية لدراسة تأثير ٣ فترات رى (الرى كل أسبوع- كل اسبوعين- كل ٣ اسابيع) و ٤ معاملات من التسميد (٦٠ كجم ن/الفدان – سماد الدواجن بمعدل ٨ طن/ الفدان - منتج تجارى يحتوى على Rhizobacterien (Azospirillum, - Azotobacter, Kebsiella, and *Bacillus* sp. + ٣٠ كجم ن/ الفدان) على إنتاجية عباد الشمس حيث وضعت معاملات الرى فى القطع الرئيسية ومعاملات التسميد فى القطع المنشقة الأولى. اوضحت النتائج أن الرى كل اسبوعين اعطى أفضل النتائج لكل الصفات المدروسة كما اعطت معاملة التسميد Rhizobacterien + ٣٠ كجم ن/ الفدان تأثير معنوى لكل الصفات المدروسة . كان للتفاعل بين كل من سماد الدواجن بمعدل ٨ طن/الفدان و Rhizobacterien + ٣٠ كجم ن/ الفدان مع معاملة الرى كل اسبوعين أفضل تأثير على نمو محصول عباد الشمس.

يمكن التوصية بامكانية رى محصول عباد الشمس كل اسبوعين والتسميد بال Rhizobacterien + ٣٠ كجم ن/ الفدان تحت ظروف منطقة الزراعة والظروف المشابهه لها.