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EFFECT OF MISSING IRRIGATION, MINERAL AND BIOFERTILIZERS ON SUNFLOWER IN NORTH NILE DELTA REGION

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ABSTRACT

A field trail was conducted at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, during the two successive growing seasons 2007 and 2008 to study the effect of missing irrigation at growth stages regime, application of mineral and biofertilizers on sunflower yield, yield components, chemical composition and some water relationships. The experimental design was a split plot design with 4 replicates. The main treatments are irrigation treatments which are irrigation as recommended (control), missing one irrigation at 8 pairs of leaves, missing one irrigation when flowering bud is formed, missing one irrigation during flowering stage and missing one irrigation after completeness of flowering and seed setting. Submain treatments are fertilization, 1- control treatments (without fertilizer), 2- 30 kg N/fed. into two equal doses, 3- Azotobacter + 15 kg N/fed., 4- Azospirillium + 15 kg N/fed. and 5- Azotobacter + Azospirillum + 15 kg N/fed.

The obtained results can be summarized as follows:

Water stress for sunflower at any growth stage increased seed yield, plant height, head diameter, 100 seed weight and oil yield, but oil percentage decreased. Concerning with fertilization effect splitting mineral fertilizer (urea) into two equal doses gave the best results under the present work.

The highest seasonal values for consumptive use and water applied were recorded under non-stressed treatments (control) but the lowest values recorded under treatment (E). Concerning fertilization effect the highest values recorded under non-fertilized treatment but the lowest were under treatment (5). For water utilization efficiency the lowest value recorded under non-stressed treatments but the highest was under treatment (C). Regarding to, fertilization effect the lowest value recorded under non-fertilized plants but the highest was under treatment (2).

INTRODUCTION

Sunflower is a main edible oil crop in Egypt and all over the world. There is a great reduction in its production which reaches about 90%, also, there is a wide gap between oil production and consumption so, great efforts should be implemented to overcome this problem and save the increasing requirements for population from oil. Sunflower is a good crop to be cultivated in new lands, that, it can be grown under a high level of salinity up to 2000 ppm under more due care with drainage system, therefore, this crop can be grown under a great variety from soils. This crop has a lot of properties besides above mentioned ones. It can be planted three times a year because it can grow under different climatic conditions. Also, it considers one of the most important crop for oil production its seeds contain a high percentage of oil that may be reached 40 to 45% and this oil has good physical and chemical characters. It has a high nutritional value because it contains a high percentage of protein.

The problem of limited water supply is becoming more and more urgent in Egypt due to the following features of water status. Arable land in Egypt is nearly entirely dependent on irrigation.

There is an increasing demand for water because of increasing Egypt's population which reached 82 million (an estimation of 2008). The water per capita share became less than 900 m^3/year which is considered below the water poverty level of < 1000 m^3 (El-Quousy, 1998). Irrigation is the main sector in water consumption comparing with the other sectors since it consumes about 85% of Egypt's water share. Under these conditions making rationalization for irrigation water on farm level is becoming a must. One of these methods to achieve this aim are (1) determination of irrigation water applied and (2) irrigation according to growth stages to identify the most critical stage for water deficit.

So, the main objectives of the present study were to study the effect of impact irrigation according to different growth, stages, mineral and biofertilizers application on yield. and yield components of sunflower.

This investigation aims at determination of water requirements of sunflower, determination of water consumptive use for the studied crop, specification of the most critical growth stages from irrigation point of view, role of amount and timing of irrigation water on some chemical characters, estimation of some water efficiencies and studying role of mineral and biofertilizers application on sunflower yield, its components and quality.

MATERIALS AND METHODS

A field trail was carried out at Sakha Agricultural Research Station during the two successive seasons 2007 and 2008 with the aim of studying the effect of irrigation according to growth stages, application of mineral and biofertilizers on sunflower yield, its components, some chemical characters and some water relationships. The sunflower cultivar was Sakha 53 which was planted on 19, 21 May 2007/2008, respectively and harvesting dates were on the first week of September in the two growing seasons, respectively. The station is situated at 31° N latitude, 30° 75' E longitude. It has elevation of about 6 metres above sea level (MSL).

A.Chemical and physical properties of the soil:

Chemical properties were determined according to Black *et al.* (1965). Physical properties such as field capacity (F.C.) was determined at the site. Permanent wilting point (P.W.P) was determined according to James (1988) and soil bulk density was determined according to **Vomacil (1957)**. All cultured practices were applied as recommend for the crop in the studied area except the studied parameters.

The experimental design was split plot where the main and submain treatments were randomly assigned as:

Main treatments (irrigation treatments):

A. Irrigation as recommended (control).
B. Missing one irrigation at 8 pairs

Submain treatments (fertilization):

1. **Control treatment, (zero N)**
2. 30 kg N/fed. into two equal doses (recommended)
3. Azotobacter + 5 kg N/fed.

of leaves.
C. Missing one irrigation when flowering bud is formed,
D. Missing one irrigation during flowering stage, and
E. Missing one irrigation after completeness of flowering and seed setting.

4. Azosprillium + 15 kg N/fed. and
5. Azotobacter + Azospirillum + 15 kg N/fed.

The area of main plot (irrigation treatment) is 52.5 m^2 (10.5 m length * 5 m width) and the area of sub main treatment (fertilization) is 10.5 m^2 (3 m length * 3.5 m width).

Data collection:

1. Irrigation water applied (m^3/fed.)

The irrigation water applied was calculated according to **Israelsen and Hansen Formula (1962):**

$$q = 0.0226\ D^2\ h^{½}$$

Where:

q = Irrigation flow rate cm^3,
h = Average effective head and
D = Inside diameter of the pipe, cm. The amount of water applied for each plot was calculated by using this formula:

$$a = q * T$$

Where:

a = Water volume/plot m^3,
q = Irrigation flow rate and
T = total recorded time for each plot, minute.

2. Water utilization efficiency (W.Ut.E):

(W.Ut.E) was calculated according to Michael (1978).

$$W.Ut.E = \frac{Y}{Wa}$$

Where:

W.Ut.E. = Water utilization efficiency (kg/m^3),
Y = Total yield produced, kg/fed. and
Wa = Total water applied, m^3/fed.

3. Water consumptive use (C.U):

Water consumptive use was calculated based on soil moisture depletion (SMD) according to **Hansen *et al.* (1979).**

$$Cu = SMD = \sum_{i=1}^{i=4} \left(\frac{\theta_2 - \theta_1}{100} * Dbi * Di \right)$$

Where:

W = Water consumptive use (cm) in the effective root zone (60 cm).
Di = Soil layer depth (15 cm).
Dbi = Soil bulk density (g/cm^3) for this depth.
θ_1 = Gravimetric soil moisture percentage before irrigation.

θ_2 = Gravimetric soil moisture percentage after irrigation
i = Number of soil layers (1-4).

Oil content (%):

Oil content was determined as described by the **A.O.A.C. method (1990)**, using petroleum ether (40-60°C) in soxhlet apparatus yield and yield components.

1. Seed yield, kg/fed.
2. Plant height, cm.
3. Head diameter, cm.
4. Weight of 100 seeds (g),
5. Oil percentage (%).
6. Oil yield, kg/fed.

Table (1):Mean values of chemical characteristics for the experimental site before cultivation in the two growing seasons.

Soil depth (cm)	EC dS/m	SAR	Soluble cations				Soluble anions			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO^{=}_3$	HCO^{-}_3	Cl^{-}	$SO^{=}_4$
0-20	1.15	5.44	1.9	2.1	7.3	0.1	0.0	4.5	5.8	2.7
20-40	1.28	5.29	1.8	2.5	7.8	0.1	0.0	4.5	5.5	2.3
40-60	1.34	5.58	2.0	2.80	8.70	0.1	0.0	4.5	6.1	3.1

Table (2):Some water constants.

Soil depth, cm.	F.C %	P.W.P. %	A.W%	bd g/cm^3
0-15	48.35	26.28	22.07	1.08
15-30	41.11	22.34	18.77	1.19
30-45	36.07	19.60	16.47	1.22
45-60	35.39	19.23	16.16	1.36

Where:
F.C. = Soil filed capacity (%)
P.W.P = Permanent wilting point (%)
A.W. = Soil available water (%)
bd = Soil bulk density (g/cm^3).

RESULTS AND DISCUSSION

1.Seed yield (kg/fed.):

Data presented in Table (3) showed that skipping one irrigation at any growth stage increased the mean values of seed yield in the two growing seasons. The lowest seed yield kg/fed. was recorded under non-skipping irrigation (control treatment) and it was 743.0 but the highest mean value was recorded under treatment (C) and it gave 847.3 kg/fed. Decreasing seed yield under control treatment comparing with the other irrigation treatments might be due to increasing amount of applied water under these conditions which has a bad effect on soil properties, causing, decreasing soil aeration, consequently, the rate of root respiration decreases and amount of nutrients uptake will decrease by leaching soil nutrients under increasing the amount of applied water. Therefore, forming weak plants with light seeds weight will be obtained comparing with the other irrigation treatments. These results are in a great agreement with those obtained by Paul W. Unger (1982).

Table (3): Effect of missing irrigation, mineral and biofertilizers on seed yield of sunflower grown in heavy clay soils during the two growing seasons.

Irrigation treatments \ Fertilization treatments	1		2		3		4		5		Mean
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	
A	490 f	475 g	975 b	1020 b	725 cde	750 def	755 cde	775 def	710 cde	755 def	743
B	490 f	525 g	1260 a	1255 a	750 cde	755 def	735 cde	755 def	685 de	720 def	793
C	490 f	500 g	1258 a	1265 a	825 c	850 de	775 cde	800 def	840 c	870 cd	847.3
D	485 f	480 g	1090 b	1095 b	730 cde	740 def	745 cde	780 def	755 cde	775 def	767.5
E	500 f	500 g	970 b	980 bc	660 e	690 f	810 cd	720 def	785 cde	790 def	750.5
Mean	491 c	496 c	1110 a	1123 a	738 b	757 b	764 b	786 b	755 b	782 b	780.2
Overall mean for the two growing seasons	493.5		1116.5		747.5		775.0		768.5		

Where:
A = Traditional irrigation as recommended.
B = Missing one irrigation when 8 pairs of leaves are formed,
C = Missing one irrigation when flowering pods are formed,
D = Missing one irrigation during flowering time and
E = Missing one irrigation after completeness flowering.

Where:
1 = Control treatment (without any addition of fertilizers).
2 = Applying 30 kg N unit into two equal doses.
3 = Azotobacter + 15 kg N/fed.
4 = Azsopriolium + 15 kg N/fed.
5 = Azotobacter + Azospirillum + 15 kg N/fed.

They concluded that making stress for sunflower plants gave a good seed yield comparing with full irrigation. Data in the same table showed that the mean values of sunflower seed yield were clearly affected by fertilization treatments, where seed yield was increased by adding mineral and biofertilizers comparing with control treatment (without adding fertilization) which gave the lowest mean value and it was 493.5 kg/fed. The highest mean value was recorded under treatment (2), with applying 30 kg N unit into two equal doses and the mean value was 1116.5 kg/fed. These results are in a great harmony with those obtained by El-Ahmer *et al.* (1980) who reported that application of 30 kg N/fed. significantly increased seed yield.

2.Plant height (cm):

Data in Table (4) illustrated that plant height were completely affected by both irrigation and fertilization treatments. The shortest plants were recorded under non-skipping irrigation treatment (control) and it is 149.86 cm. On the contrary, the tallest plants were recorded under treatment (E) and the value was 153.61 cm. Decreasing plant height under control treatment might be due to increasing the amount of irrigation water, so, it helps nutrients to be leached and ran away from the effective root zone, therefore, the amount of nutrients will be decreased so, upright movement for plants will be reduced and formed short plants. Also, this crop is more sensitive for irrigation, therefore, it needs irrigation with more due care. These results are in a great satisfaction with those obtained by S.A. Ouda *et al.* (2006). Who reported that yield and yield components were improved by reducing amount of applied water.

Regarding fertilization treatments, the shortest plants were recorded under control treatment (without fertilization) and it is 149.15 cm. On the other hand, the tallest plants were recorded under treatment (2) and the value is 155.0 cm. These results might be due to splitting nitrogen dose into two equal doses giving a great opportunity for plants to take their nutritional requirements. These results are in a great harmony with those results obtained by Abou Ghazala *et al.* (1996) who concluded that the most economic fertilization treatments for the maximum yield, yield components in the north Delta region were 30 kg N/fed., 15 P_2O_5/fed. and 241 kg K_2O/fed.

3.Head diameter:

Data in Table (5) illustrated that the mean values of head diameter were increased under all irrigation treatments (skipping one irrigation at any growth stage) comparing with control (irrigation without skipping) where the smallest head were recorded and it is 13.73 cm. On the contrary, the biggest heads were 14.05 cm which recorded under irrigation treatment (E). Increasing sunflower head diameter under skipping one irrigation at any growth stage comparing with continuous irrigation might be due to that under skipping irrigation plants penetrate their roots in the soil to take their nutritional needs with a great amount so, formed strong plants with good head diameter comparing with control treatment where plants take their nutritional requirements without exerting any effort. Forming plants with little head diameter. These results are in a great harmony with those obtained by Paul W. Unger 1982).

Table (4): Effect of missing irrigation, mineral and biofertilizers on sunflower plant height grown in heavy clay soils during 2007 and 2008 seasons.

Irrigation treatments \ Fertilization treatments	1		2		3		4		5		Mean
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	
A	146.3 e	144.0 j	148.7 a-e	159.0 a-d	147.0 de	150.7 hi	148.3 b-e	154.3 c-f	147.3 de	153.0 e-h	149.86
B	151.7 a	153 e-h	148.0a-e	151.7 ghi	148.0a-e	160.7 abc	149.0 a-e	158.0 a-e	147.7 cde	153.0 e-h	152.18
C	149.0 a-e	148.0 ij	148.3b-e	160.3a-d	148.0b-e	152.0 ij	148.0 b-e	154.3 efg	151.0 ab	152.3 e-h	151.12
D	148.3 b-e	150.7 d-g	149.3 a-e	162.0 a-d	1489.3 b-e	157.9 hi	149.0 a-e	1530 e-h	148.3 b-e	157.7 a-f	152.45
E	148.3 b-e	153.7 e-h	148.7 a-d	164.0 a	150.0 a-d	160.7 abc	150.7 abc	157.0 b-f	150.0 a-d	153.0 e-i	153.61
Mean	148.7 a	149.6 c	148.8 a	161.23 a	148.3 a	155.7 b	149.0 a	154.3 b	149.9 a	155.1 b	151.96
Overall mean for the two seasons	149.15		155.0		152.0		151.65		152.0		

Table (5): Effect of missing irrigation, mineral and biofertilizers on sunflower head diameter grown in heavy clay soils during the two growing seasons.

Fertilization treatments / Irrigation treatments	1		2		3		4		5		Mean
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	
A	13.2 cd	13.3 c	13.3 bcd	14.9 abc	13.7 a-d	13.8 abc	13.7 a-d	14.3 abc	13.0 d	14.1 abc	13.73
B	14.2 ab	13.2 c	13.4 bcd	15.6 a	13.5 a-d	14.0 abc	13.9 a-d	14.5 abc	13.3 bcd	14.8 abc	14.04
C	14.0 abc	13.4 bc	13.3 bcd	15.2 ab	13.7 a-d	14.3 abc	13.0 d	14.1 abc	13.3 bcd	14.5 abc	13.88
D	13.2 cd	13.2 c	13.2 cd	15.3 a	14.2 ab	14.4 abc	13.3 bcd	15.0 abc	13.2 cd	14.5 abc	13.95
E	13.0 d	13.4 bc	13.5 a-d	15.4 a	13.8 a-d	14.7 abc	13.7 a-d	13.3 abc	14.3 a	15.4 a	14.05 a
Mean	13.5 a	13.3 c	13.3 a	15.3 a	13.8 a	14.3 b	13.5 a	14.4 b	13.4 a	14.6 ba	13.94
Overall mean for the two growing seasons	13.4		14.3		14.05		13.95		14.0		

Concerning with, fertilization treatments the smallest heads of sunflower were increased by applying fertilization (both mineral and biofertilizers) comparing with control (non-fertilized) recording the lowest mean value. The highest mean value is 14.3 cm was recorded under treatment (2) (splitting nitrogen into two equal doses) instead of one dose. These findings are in a great harmony with those obtained by Vijayakumar and Ramesh (2005). They reported that splitting application of nitrogen resulted in improving yield and yield components comparing with full basal application.

4.100 seed weight (g):

Data presented in Table (6) showed that the mean values of 100 seed weight were increased by skipping irrigation at any growth stage comparing with control treatment (continuous irrigation) where the lowest mean value was 5.32 (g). On the contrary, the highest mean value was recorded under (treatment C) and it is 5.73 (g). These findings are in a great harmony with those obtained by Teama and Mahmoud (1994). Concerning with, fertilization, the lowest mean value was recorded under non-application fertilizers and it is 5.27 (g). On the other hand, the highest mean value was recorded under treatment (2) and it is 5.73 (g). These results are in a great harmony with those obtained by Kill (2004).

5.Oil percentage (oil %):

Data in Table (7) showed that both irrigation and fertilization treatments revealed a significant difference in values for oil percentage. The mean values were rather similar in the two growing seasons. These findings are in a great harmony with those obtained by Ouda *et al.* (2006) and Vijayakumar and Ramesh (2005).

6.Oil yield (kg/fed.):

Presented data in Table (8) showed that the mean values of oil yield were increased by skipping one irrigation at any growth stage comparing with control treatment (continuous irrigation) where the lowest mean value was recorded and it is 260.16 kg/fed. On the contrary, the highest mean value is 323.90 kg/fed. and it was recorded under treatment (c). These results are in a great harmony with those obtained by Paul W. Unger (1982) who reported that making skipping irrigation at any growth stage gave good properties comparing with full irrigation during the whole growing season.Concerning with fertilization effect on oil yield, the lowest mean value was recorded under control treatment (non-application of fertilizers) and it is 188.5 kg/fed. but the highest mean value was recorded under treatment (2) and it is 426.04 kg/fed. These results are in a great harmony with those obtained by Abou-Ghazala *et al.* (1996), who concluded that the most economic fertilization treatments for the maximum seed yield and yield components in the north Delta region were 30 kg N/fed., 15 kg P_2O_5/fed. and 24 kg K_2O/fed.

Water consumptive use (m^3/fed.):

Data in Table 9 illustrated that the seasonal values of consumptive use were affected by missing irrigation under the same fertilization treatments. The highest seasonal values were recorded under control treatment (A) (irrigation as recommended) and the values are 2240.09 and 21204.62 m^3/fed.

Table (6): Effect of missing irrigation, mineral and biofertilizers on sunflower 100 seed weight (g) grown in heavy clay soils during the two growing seasons.

Fertilization treatments / Irrigation treatments	1		2		3		4		5		Mean
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	
A	5.97 abc	4.57 i	5.127 efg	5.47 a-f	5.77 a-d	5.00 d-i	5.47 c-g	4.93 e-i	5.57 b-g	5.30 b-i	5.32
B	5.80 a-d	5.07 c-g	5.70 a-f	5.67 a-d	6.30 a	5.10 c-h	5.73 a-e	5.60 a-e	6.13 ab	5.50 a-e	5.66
C	6.13 ab	4.70 hi	6.30 a	5.77 abc	6.23 a	5.37 b-f	5.70 a-f	5.73 abc	5.70 a-f	5.63 b-f	5.73
D	5.23 d-g	4.80 ghi	5.33 d-g	5.83 ab	5.10 fg	5.67 a-d	5.90 abc	5.67 a-d	5.97 abc	5.63 a-e	5.51
E	5.57 b-f	4.87 f-i	5.90 abc	6.13 a	5.07 g	5.57 a-e	4.97 g	5.50 a-e	5.00 g	5.70 a-d	5.43
Mean	5.74 a	4.80 c	5.68 a	5.77 a	5.69 a	5.34 b	5.55 a	5.49 b	5.67 a	5.5 ab	5.52
Overall mean for the two growing seasons	5.27		5.73		5.52		5.52		5.59		

Table (7): Effect of missing irrigation, mineral and biofertilizers on sunflower oil percentage grown in heavy clay soils during the two growing seasons.

Fertilization Treatments / Irrigation treatments	1		2		3		4		5		Mean
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	
A	38.1	38.3	38.4	38.5	38.9	398.9	38.7	38.7	38.2	38.3	38.5 ab
B	38.6	38.7	38.4	38.4	388	38.8	37.9	38.2	38.5	38.5	38.48 b
C	38.3	38.4	38.3	38.4	38.7	38.8	38.5	38.7	38.3	38.6	38.5 ab
D	37.7	38.0	38.6	38.6	38.8	38.8	38.4	38.4	38.4	38.5	38.42 c
E	37.8	38.1	38.6	38.7	38.9	38.97	38.6	38.7	38.4	38.4	38.52 a
Mean	38.1	38.3	38.46	38.52	38.82	38.85	38.42	38.54	38.36	38.46	38.48 b
Overall mean for the two growing seasons	38.2 d		38.49 b		38.84 a		38.48 b		38.41 c		

Table (8): Effect of missing irrigation, mineral and biofertilizers on sunflower oil yield kg/fed. grown in heavy clay soils during the two growing seasons.

Fertilization treatments / Irrigation treatments	1		2		3		4		5		Mean
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	
A	186.74	181.77	374.48	392.70	281.85	291.75	291.89	300.18	271.30	288.91	260.16 f
B	188.18	203.18	450.53	481.50	291.00	292.53	278.77	288.16	263.47	277.20	301.45 b
C	187.83	192.00	483.20	485.34	294.90	329.80	298.60	309.33	321.89	336.11	323.90 a
D	182.97	182.40	420.27	422.67	282.20	287.12	286.07	299.52	290.23	298.38	295.16 d
E	189.33	190.67	374.30	375.39	256.77	257.18	312.70	313.47	301.10	301.44	287.24 e
Mean	187.00	190.00	420.56	431.52	281.34	2591.68	293.61	302.13	291.40	300.41	298.9 c
Overall mean for the two growing seasons	188.5 e		426.04 a		286.51 d		297.87 b		295.91 c		

Table (9): Sunflower consumptive use m^3/fed. and by cm. under water stress, mineral and biofertilizers application in heavy clay soils in the two growing seasons.

Fertilization treatments / Irrigation treatments	1		2		3		4		5		Seasonal m^3/fed.
	m^3/fed.	cm	m^3/fed.	cm	m^3/fed.	cm	m^3/fed.	cm	m^3/fed.	cm	
	1st growing season										
A	497.97	19.0	487.02	11.60	442.06	10.53	422.43	10.06	390.61	9.30	2240.09
B	416.44	9.92	399.79	9.52	314.45	7.49	319.19	7.60	292.95	6.98	1742.82
C	385.99	9.19	385.73	9.18	353.18	8.41	327.34	7.79	285.14	6.79	1737.38
D	401.27	9.55	387.36	9.22	349.82	8.33	334.30	7.96	304.67	7.25	1777.42
E	374.68	8.92	368.32	8.77	326.62	7.78	318.83	7.59	284.45	6.77	1672.9
Seasonal	2076.35	56.57	2028.22	48.29	1786.13	42.54	1722.09	41.0	1557.82	37.09	
	2nd growing season										
A	498.63	11.87	486.42	11.58	436.34	10.39	410.07	9.76	373.16	8.88	2204.62
B	426.38	10.15	403.55	9.61	340.29	8.10	323.21	7.70	298.57	7.11	1792.0
C	396.39	9.44	391.96	9.33	360.30	8.58	340.34	8.10	314.46	7.49	1803.45
D	404.41	9.63	391.44	9.32	356.31	8.48	338.09	8.05	312.46	7.44	1802.71
E	382.51	9.11	375.39	8.94	336.30	8.01	324.03	7.72	290.42	6.91	1708.65
Seasonal	2108.32	50.2	2048.76	48.78	1829.54	43.56	1735.74	41.33	1589.07	37.83	

On the contrary, the lowest seasonal values were recorded under treatment (E) and the values are 1672.9 and 1708.65 m^3/fed. in the first and second seasons, respectively. Increasing the seasonal values of consumptive use under treatment (A) might be due to increasing number of irrigations and consequently amount of applied water as a result of increasing transpiration through plant surface and evaporation from the soil. Decreasing the seasonal values under treatment (E) might be due to less water requirements for plants were decreased comparing with other irrigation treatments. These results are in a great harmony with those obtained by Doorenbos *et al.* (1979). Who reported that values of seasonal consumptive use for sunflower in semi arid regions are varying between 60 and 100 cm depending upon climate and available soil moisture.

Data in the Table (9) showed that fertilization treatments have a great effect on values of consumptive use. The highest values were recorded under control treatment (1) and the values are 2076.355 and 2108.32 m^3/fed. On the other hand, the lowest values were recorded under treatment (5) and the values are 1557.82 and 1589.07 m^3/fed. in the first and second growing seasons, respectively.

Irrigation water applied (m^3/fed.):

Sunflower is a summer crop, which grows in Egypt under irrigation condition. Amounts of irrigation water (I.W) applied throughout the seasons for different treatments are presented in Table 10. The highest season values for (I.W) were recorded under control treatment (A) and the values are 3733.49 and 3674.36 m^3/fed. but the lowest values were recorded under treatment (E) and the values are 2788.17 and 2847.75 m^3/fed. in the first and second growing seasons, respectively. These results are in a great harmony with those obtained by Dubbelde *et al.* (1982) who concluded that total crop water use for sunflower under semi arid conditions varied from 1033 to 4019 m^3/fed.

Data in the same Table showed that fertilization treatments affected the values of irrigation water applied where the highest values were recorded under control treatment (treatment 1) and the values are 3460.59 and 3513.87 m^3/fed., but the lowest values were recorded under treatment(s) and the values are 2596.36 and 2648.45 m^3/fed. in the first and second growing seasons, respectively.

Water utilization efficiency (W.Ut.E) kg/m^3:

Presented data in Table 11 showed that the mean values of (W.Ut.E) increased by skipping irrigation at any growth stage comparing with control which recorded the lowest mean values and they are 0.99 and 1.04 kg/m^3. On the other hand, the highest mean values were recorded under treatment (C) and the mean values are 1.46 and 1.44 kg/m^3 in the first and second growing seasons, respectively. This might be due to increasing seed yield under this treatment in comparison with the other irrigation treatments. Decreasing mean values of (W.Ut.E) under control treatment might be due to increasing amount of water applied under this treatment.

Table (10): Amount of water applied of sunflower crop as affected by water stress and application of mineral and biofertilizers in heavy clay soils in the two growing seasons.

Irrigation treatments \ Fertilization treatments	1	2	3	4	5	Seasonal m^3/fed.
	1st growing season					
A	82.9.95	811.7	736.77	704.05	651.02	3733.49
B	694.07	666.32	524.08	531.98	488.25	2904.7
C	643.32	642.88	588.63	545.57	475.23	2895.63
D	668.78	645.6	583.03	557.17	507.78	2962.37
E	624.47	613.87	544.37	531.38	474.08	2788.17
Seasonal m^3/fed.	3460.59	3380.37	2976.88	2870.15	2596.36	
	2nd growing season					
A	831.05	810.7	727.23	683.45	621.93	3674.36
B	710.63	672.58	567.15	538.68	497.62	2986.66
C	660.65	653.27	600.5	567.23	524.1	3005.75
D	674.02	652.4	593.85	563.48	520.77	3004.52
E	637.52	625.65	560.5	540.05	484.03	2847.75
Seasonal m^3/fed.	3513.87	3414.6	3049.23	2892.89	2648.45	

Fertilization treatments also have a great effect on the mean values of (W.Ut.E) in the two growing seasons. The lowest mean values were recorded under control treatment and the mean values are 0.72 and 0.71 kg/m^3. On the contrary, the highest mean values were recorded under treatment (2) and the mean values are 1.71 and 1.66 kg/m^3 in the first and second growing seasons, respectively. This might be due to increasing seed yield under this treatment in comparison with the other treatments.

Table (11): Water utilization efficiency (W.Ut.E) kg/m^3 of sunflower crop as affected by water stress and application of mineral and biofertilizers in heavy clay soils in the two growing seasons.

Irrigation treatments \ Fertilization treatments	1	2	3	4	5	Mean
	1st growing season					
A	0.59	1.20	0.98	1.07	1.09	0.99
B	0.71	1.90	1.43	1.38	1.40	1.36
C	0.76	1.96	1.40	1.42	1.77	1.46
D	0.73	1.69	1.25	1.34	1.49	1.30
E	0.80	1.78	1.36	1.47	1.63	1.41
Mean	0.72	1.71	1.28	1.34	1.48	
	2nd growing season					
A	0.57	1.26	1.03	1.13	1.21	1.04
B	0.74	1.86	1.33	1.40	1.45	1.36
C	0.76	1.94	1.41	1.41	1.66	1.44
D	0.71	1.68	1.25	1.38	1.49	1.30
E	0.78	1.55	1.18	1.50	1.45	1.29
Mean	0.71	1.66	1.24	1.36	1.45	

REFERENCES

Abou-Ghazala, M.E.; N.R. Guirguis and F.A. El-Kady (1996). Response of sunflower to different levels of N, P and K fertilization. Adv. Agric. Res. Vol. (1): No. (1): 11-19, 1996.

A.O.A.C. (1990). Official Methods of Analysis of the Association of Official Analytical Chemists, 15th (edition, published by Association of Official Analytic Chemists, Arlington, Virginia, U.S.A.

Black, C.A.; D.D. Evans; L.E. Ensmigger; J.L. White and F.E. Clark (1965). Methods of Soil Analysis. Amer. Soc. Agron. Inc., Madison, Wisconsin U.S.A.

Doorenbos, J.; A.H. Kassam; C.L.M. Bentvelsen and H.K. Wall (1979). Sunflower yield response to water irrigation and drainage No. 33, FAO, Rome.

Dubbelde, E.A.; H.C. Harris and J.R. McWilliam (1982). Water requirements of sunflower in a semi-arid environment. Proceeding of the 10th International Sunflower Conference, Australian Sunflower Association: 62-65. (C.F. Soils and Fert.; 46: Abst. No. 1081).

El-Ahmer, B.A.; F.M. El-Rayes; A.O. Omran and A. Ali (1980). Effect of N, P, K and the different combinations on seed yield, oil content and other economic characters of sunflower (*Helianthus annuus* L.). Agric. Res. Rev., 58: 117-135 Ministry of Agric., Egypt.

El-Quyosy, D. (1998). The challenge for water in the twenty first century: The Egyptian experience. Arab Water 78 Ministry of Water Resources and Irrigation (MWRI), April 26-28, 1998, Cairo, Egypt.

Garcia, G. (1978). Soil Water Engineering Laboratory Manual. Colorado State Univ. Dept. of Agric. and Chemical Engineering. For Collins, Colorado 80523.

Hansen, V.W.; O.W. Israelsen and Q.E. Stringharm (1979). Irrigation principles and practices, 4th ed., John Willey and Sons, New York.

Israelsen, D.W. and V.E. Hanbsen (1962). Flow of water into and through soils. Irrigation Principles and Practices. 3rd Edition, John Willey and Sons, Inc., New York, N.Y., USA.

Kill, F. (2004). Influence of different nitrogen levels on productivity of oil seed and confection sunflowers (*Helianthus annuus* L.) under varying plant populations. International Journal of Agriculture. and Biology (2004), (4): 594-598.

Michael, A.M. (1978). Irrigation theory and practice Vikas Publishing House, PVT, Ltd. USA.

Ouda, S.A.; M.S. Gaballah; M.M. Tantawy and T. El-Mesiry (2006). Irrigation optimization for sunflower grown under saline conditions Research Journal of Agriculture and Biological Science 2(6): 323-327, (2006).

Paul W. Unger (1982). Time and frequency of irrigation effects on sunflower production and water use. Published in Soil Sci. Soc. Am. J. 46: 1072-1076 (1982).

Snedecor, W.G. and W.G. Cochran (1967). Statistical methods. 6th ed. Iowa State Univ., USA.

Teama, E.A. and A.M. Mahmoud (1994). Response of sunflower for watering regimes and nitrogen fertilization 1- growth characteristics Assiut Journal of Agricultural Sciences, Vol. 25, No. 5, 1994.

Vijayakumar, M. and S. Ramesh (2005). Effect of crop geometry and nitrogen management on growth analysis and yield of rain-fed sunflower (*Helianthus annuus*). Journal of Ecotoxicology and Environmental Monitoring 15(4): 371-376, (2005).

Vomocil, J.A. (1957). Measurements of Soil bulk density and penetrability A review of Methods Adv. Agric. 9, New York, London, Edited by Norman A.G., pp. 157-176.

تأثير حرمان الرى والاسمدة المعدنية والحيوية علـى محـصول دوار الـشمس بمنطقة شمال الدلتا

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نفذت تجربة حقلية فى محطة البحوث الزراعية بسخا ــ محافظة كفرالشيخ خلال موسمى النمـو ٢٠٠٧ ، ٢٠٠٨م لدراسة تأثير حرمان الرى خلال مراحل النمو ، إضافة الأسمدة المعدنية والحيوية علـى محصول عباد الشمس ومكوناته والخصائص الكيماوية وبعض العلاقات المائية.

التصميم الاحصائى هو القطع المنشقة مرة واحدة وعدد المكررات ٤ مكررات حيث المعـاملات الرئيسية هى معاملات الرى وكانت أ- رى حسب الموصى به (الكنترول) ، ب- حرمان ريه فـى مرحلـة تكونين ٨ أزواج من الاوراق ، جـ- حرمان ريه فى تكوين البراعم الزهرية ، د- حرمان ريه فى التزهير ، هـ- حرمان ريه عند اكتمال التزهير . المعاملات تحت الرئيسية هـى معـاملات التـسميد حيـث ١- الكنترول (بدون تسميد) ، ٢- ٣٠ كجم نتروجين/فدان على دفعتين ، ٣- اضافة الازوتوباكتر + ١٥ كجـم نتروجين/فدان ، ٤- الايزوسبيرليم + ١٥ كجم نتروجين/فدان ، ٥- الازوتوباكتر + الايزوسـبيرليم + ١٥ كجم نتروجين/فدان.

النتائج المتحصل عليها يمكن تخليصها كما يلى:

- دلت النتائج المتحصل عليها أن حرمان رية فى أى مرحلة من مراحل النمو زاد محصول البذرة ، طول النبات ، قطر القرص وزن الـ ١٠٠ بذرة ومحصول الزيت ونقصت النسبة المئوية للزيت فى البذور ، بالنسبه لتأثير التسميد دلت النتائج على أن لم تكون هناك استجابة لمعاملات التسميد النتروجينـى ولكـن اعطت المعاملة رقم (٢) التسميد بمعدل (٣٠ كجم) اعلى القيم.
- عمل تجزئة للسماد المعدنى على دفعتين متساويتين أعطت أحسن النتائج تحت نظام الدراسة.
- كانت أعلى القيم بالنسبه للاستهلاك المائى والماء المضاف تحت المعاملات التى لم يحدث لهـا حرمـان وأقلها تحت المعاملة (E).بالنسبه لتأثير التسميد كانت أعلى القيم تحت فى المعاملات التـى لـم تـسمد وأقلها تحت المعاملة (5). بالنسبه لكفاءة استخدام المياه كانت اقل القيم تحت المعاملة التى لـم تعـرض لحرمان وأعلاها كانت تحت المعاملة (C). أما بالنسبة لتأثير معاملات التسميد فقد اعطت معاملة عـدم الحرمان اقل القيم بينما اعطت المعاملة (C) اعلى القيم.

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