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DETERMINING THE OPTIMUM IRRIGATION INTERVALS AND PLANT DENSITIES FOR SUNFLOWER UNDER DRIP IRRIGATION SYSTEM.

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ABSTRACT

Two field experiments were carried out in the modernized irrigation system network (drip irrigation technique) at the research farm at Sakha Agricultural Research Station, kafr El- Sheikh Governorate during the two successive growing seasons 2007 and 2008. The target of this present study was to investigate the impact of irrigation intervals on yield, its quality and some water relationships.

Obtained data can be concluded as follows: -

- Seed yield was clearly increased by decreasing irrigation interval where the highest means values were recorded under the shortest interval (4 days) and the values were 1.03 and 1.08 ton/ fed. (2.45 and 2.57 ton/ ha) in the first and second growing seasons, respectively. Also, data showed that there wasn't a pronounced difference among 8, 12 and 16 days irrigation intervals where the values were rather similar, but under 20 days irrigation interval, the value of seed yield was clearly decreased.
- Mean values of 1000 seed weight (g) were increased under irrigation interval each 4 days in comparison with other irrigation intervals 8, 12, 16 and 20 days where the highest mean values were 65.287 and 65.403 g in the first and second growing seasons, respectively. On the contrary, the lowest mean value was recorded under 20 days irrigation interval.
- In addition, data illustrated that the mean values of and head diameter was decreased by increasing irrigation interval up to 20 days. The highest mean values for the studied parameter was recorded under the shortest irrigation interval each 4 days in the two growing seasons, where the mean values for the studied parameter was 19.073 cm for head diameter.
- The highest mean values of plant height were recorded under 8 days interval in the first growing season, and under 12 days, in the second growing one and the mean values were 167.533 and 157.367 cm, respectively. On the other hand, presented data showed that there wasn't clear and standard relationship between plant densities and the studied parameters.
- Also, data illustrated that by elongation irrigation interval up to 20 days caused decreasing amount of water applied was found, where the highest mean values were recorded under the shortest interval of irrigation each 4 days and the values were1482.04 and 1556.8 m^3/ fed in the first and second growing seasons, respectively. On the contrary, the lowest values were recorded under the longest irrigation interval 20 days between watering and the values were 1135.64 and 1110.0 m^3/ fed. in the first and second seasons, respectively.
- Concerning the values of water utilization efficiency (W.Ut.E) which clearly affected by irrigation interval where the highest values were recorded under the shortest irrigation interval each 4 days where the values were 0.67 and 0.71 kg/ m^3 in the first and second growing seasons, respectively. Under the other irrigation intervals 8, 12, 16 and 20 days the values were low comparing with the first

treatment (interval of 4 days) but there wasn't a standard and clear relationship between the other irrigation intervals (8, 12, 16 and 20) days.

- Data also illustrated that the highest mean values for oil content in seeds were recorded under 16 days between irrigations.

Keywords: sunflower, irrigation interval, water utilization efficiency

INTRODUCTION

Egypt suffers from a great deficiency in production of edible crops. So, we should pay attention to increase the productivity of edible crops. Sunflower is one of the most important crops because it has a high oil content which reached about 45%, this kind of oil has a high good physical and chemical characteristics. This crop can be grown well in new reclaimed lands and under the high level of salinity which may be reached 2000 ppm particularly under a good drainage system. Also, it can be cultivated three times a year and under different climatic conditions. There is a wide gap between oil production and consumption, therefore, efforts should be implemented to decrease this gap by increasing its production quantitively and qualititively.

In Egypt, water resources have become limited in relation to possible land reclamation (horizontal agricultural expansion).

Great efforts should be implemented to overcome the problem of water shortage that facing Egypt after along drought of Nile resources in Africa. Sunflower is one of the crops which is more sensitive for irrigation. So, we must treat this crop with a great care regarding irrigation to keep its high production and make saving for irrigation water. In this regard water per capita share is about 800 m^3 annually, and this considers below the poverty level of < 1000 m^3/ yearly (El– Quosy 1998)

There are a lot of ways which we can apply some of them to make rationalization for irrigation water through.

1-Elongation irrigation interval without any drastic reduction in yield.
2-Using modern irrigation techniques which have a high efficiency such as drip irrigation system of about 90%.
3-Increasing plant densities which give a high yield under the same amount of water applied.

Therefore, the main target of this present work was to find out the interaction impact of irrigation interval and plant densities on sunflower yield, its quality and some irrigation parameters under drip irrigation system in the North Middle Nile Delta region.

MATERIALS AND METHODS

The present trials were conducted at Sakha Agricultural Research Station, Kafr El- Sheikh Governorate during the two successive growing seasons 2007 and 2008 to study the impact of irrigation intervals and plant densities on sunflower production (CV. Sakha 53) and some water relationships under drip irrigation technique. The some soil physical, chemical characteristics and chemical properties of irrigation water are tabulated in Tables (1, 2 and 3).

Table 1: Soil physical and chemical properties and soil – water constants.

Soil depth, cm	Physical properties							
	Particle size distribution			Texture	F.C* %	P.W.P**%	Available water %	Bulk density, g/ cm^3
	Sand %	Silt %	Clay %					
0-20	19.50	23.45	57.05	Clayey	43.00	22.00	21.00	1.14
20-40	18.22	22.19	59.05	Clayey	40.00	21.00	19.00	1.24
40-60	17.37	22.31	60.32	Clayey	39.00	21.00	18.00	1.32

Table 2: Soil chemical properties of the experiments.

Soil depth cm	SAR	ESP	E.C, dS/m	Soluble cations, meq/ l				Soluble anions, meq/ l				pH
				Ca^{++}	Mg^{++}	Na^{++}	K^{+}	CO_3^{--}	HCO_3^{-}	CL^{-}	$So4^{--}$	
0-20	7.13	8.45	1.92	4.04	2.22	12.62	0.18	0.0	5.5	8.8	4.76	7.9
20-40	7.16	8.46	1.89	4.08	2.20	12.68	0.18	0.0	5.4	8.9	4.84	8.0
40-60	7.19	8.59	1.93	4.16	2.28	12.90	0.16	0.0	5.5	9.0	5.00	8.1

Table 3: Chemical properties of irrigation water

E.C, dS/m	Soluble cations, meq/l				Soluble anions, meq/l			
	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	CL^{-}	SO_4^{--}
0.44	2.48	1.17	0.84	0.154	0.0	2.00	0.96	1.68

***F.C: soil field capacity **P.W.P: permanent wilting point.**

The drip irrigation system consists of a pumped unit which contains a pump, control unit, groups of pipes which differ in its diameter and distribution lines. The control unit of the system contains a venture injector (25.4 mm), fertilizer tank, disk filters, control valves and a water flow meter. Distribution lines consists of polyethylene (PE) pipes manifolds (display and discharge) laterals of 16 mm in diameter and 40 m in length had in– line emitters spaced 0.5 m apart, each delivering 4 l h^{-1} at a pressure of 1 bar. Drip irrigation lines were spaced 0.8 m apart equally spaced between every other row of sunflower. Water was applied from a pressurized hydrant and filtered through gravel and refiltered through disk filters. The texture of the experimental field soil is heavy clay. Water table level is a bout 150 cm.

The treatments were arranged in split plot design with four replicates as follows: -

- **Main treatments (irrigation intervals)**

  I_1 – Irrigation every 4 days. I_2 – Irrigation every 8 days.
  I_3 – Irrigation every 12 days. I_4 – Irrigation every 16 days.
  I_5 – Irrigation every 20 days.

- **Sub main treatments (plant densities)**

D_1- Planting on one lateral with one plant from each side adjusted with the emitter.

D_2- Planting on one lateral with two plants from each side adjusted each the emitter.

D_3- Planting on one lateral with two plants adjusted with the emitter, one plant from each side.

D_4- Planting on one lateral with four plants on the two sides from the emitter, two plants from each side.

D_5- Planting on one lateral with four plants on the two sides of the emitter, two plants from each side. In addition, two plants were planted in the middle of the two adjacent emitters one plant in each side.

In the two seasons, sunflower as a summer crop was planted on June, 18 and harvested on September 18. All agronomic practices and fertilization were done as recommended for the crop and the area except the treatments under study.

Data collection:

1- Irrigation water applied (IW).

The amount of applied water at each irrigation was measured by using flow meter.

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

It was calculated according to the following equation (Michael, 1978).

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

where: Y = seed yield (kg/ feddan)

IW = irrigation water applied, m^3 /fed.

- Yield and its components
- Seed yield (ton/ fed)
- Plant height (cm)
- Stem diameter (cm)
- Head diameter (cm)
- Weight of 1000 seed (g)
- Head weight (g) .

RESULTS AND DISCUSSION

Seed yield (ton/ fed)

Presented data in Tables (4 through 7) clearly showed that under all plant densities, mean values of sunflower seed yield were greatly affected by irrigation intervals from 4 to 20 days. In the two growing seasons the highest mean values were recorded under the shortest irrigation interval every 4 days and the values were 1.03 and 1.08 ton/ fed. On the other hand the lowest mean values were registered under the longest irrigation interval every 20 days and the mean values were 0.56 and 0.58 ton/ fed in the first and second growing seasons, respectively .

Increasing seed yield under the shortest irrigation interval (4days) comparing with the other irrigation intervals may be due to under the amount of water applied is enough to increase the availability of nutrients. Which caused increasing its uptake by plants and hence, increasing seed yield. These findings are in a great harmony with those obtained by Ashoub *et al.*, 2000, they reported that decreasing irrigation intervals from 21 to 14 or from 14 to 7 days gave significant increasing in seed yield. These results are in a great harmony with those obtained by Omar *et al.* (2008).

Table 4: Effect of irrigation interval and plant densities on sunflower seed yield (ton/ fed) grown under drip irrigation system in the Nile Delta in 2007 growing season.

Plant density	Irrigation interval (I)				
	I_1	I_2	I_3	I_4	I_5
D_1	1.37a	0.73 b	0.83 a	0.70a	0.57a
D_2	1.07b	0.67b	0.77a	0.80a	0.57a
D_3	1.03b	1.13a	0.73a	0.70a	0.47a
D_4	0.67c	0.47c	0.50a	0.70a	0.57a
D_5	1.03b	0.73b	0.77a	0.70a	0.63a
I – mean	1.03	0.75	0.72	0.72	0.56

CV (a) = 14.2 % CV (b) = 15.8%

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT .

Table 5: Interaction effect between irrigation intervals and plant densities on seed yield (ton/ fed) in 2007 growing season.

Plant density	D – mean
D_1	0.84
D_2	0.77
D_3	0.81
D_4	0.58
D_5	0.77
I – mean	0.76

Comparison	S.E.D.	LSD 5%	LSD 1%
2- I means at each D	0.10	0.20	0.27
2- D mans at each I	0.10	0.20	0.26

Table 6: Effect of irrigation intervals and plant densities on sunflower seed yield (ton/ fed) grown under drip irrigation system in the Nile Delta in 2008 growing season .

Plant density (D)	Irrigation interval (I)				
	I_1	I_2	I_3	I_4	I_5
D_1	1.30a	0.92a	0.83a	0.79a	0.66a
D_2	1.10b	0.68c	0.82a	0.75a	0.63ab
D_3	1.07bc	0.72c	0.69b	0.71ab	0.56bc
D_4	1.00cd	0.76bc	0.66b	0.71ab	0.53c
D_5	0.95 d	0.81b	0.68b	0.65b	0.50c
I – mean	1.08	0.78	0.74	0.72	0.58

CV (a) = 9.9 % ; CV (b) = 6.3 %

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Table 7: Interaction effect between irrigation intervals and plant densities on seed yield (ton/ fed) in 2008 season.

Plant density (D)	D - mean
D_1	0.90
D_2	0.80
D_3	0.75
D_4	0.73
D_5	0.72
I – mean	0.78

Comparison	S.ED	LSD 5%	LSD 1%
2-I means at each D	0.05	0.10	0.13
2- D means at each I	0.04	0.08	0.11

Results can be concluded that irrigation every 4 days caused saving water gives healthy and good plants and therefore, good and high seed yield. On the other hand, under shortage or limited of irrigation water we recommend that irrigation interval may be reached to16 days between irrigations because there isn't a significant difference between 8, 12 and 16 days in yield.

Concerning plant densities, results showed that no significant differences between all treatments. So, we can recommend that, cultivation with one plant at each dripper is preferable in comparison with other plant densities. Using this method in cultivation always makes saving water for seeds through planting.

1000-seed weight (g)

Presented data in Tables (8 through 11) showed that the mean values of 1000 seed weight were clearly affected by irrigation interval under all plant densities. The highest mean values for 1000 seed weight were increased by decreasing irrigation interval, where, the highest mean values were recorded under 4 days treatment in comparison with the other treatments 8, 12, 16 and 20 days between irrigations. The mean values were 65.287, 64.660, 57.187, 55.753 and 54.500 (g) under 4, 8, 12, 16 and 20 days between irrigations in the first growing season, respectively. Data in the same tables illustrated that the same trend was obtained in the second growing season and the mean values were rather similar to the first season. In the two growing seasons the lowest mean values were recorded under the longest irrigation interval 20 days. Data in the same tables clearly showed that plant densities decleared a great effect on weight of 1000 seed where the highest mean values were recorded under cultivation one plant at each dripper in one side in comparison with the other methods of plantings.

Increasing weight of 1000 seed under the shortest irrigation interval might be due to increasing amount of water applied. So, increasing solubility and availability of nutrients, raised uptake of these nutrients by plants forming filling seeds with more weight comparing with the other treatments. Increasing 1000 seed weight under the lowest plant density might be due to, a low competition between plants on their nutritional needs, therefore, forming good and healthy seeds with more weight. These results are in a great harmony with those obtained by Krogman *et.al.* 1980 who reported that seed yield or seed index was significantly increased by increasing the amount of irrigation upon depletion of 40, 60 and 75 % of available water. Also, these results are in a great harmony with those obtained by Maksimovic (2005).

Table 8: Effect of irrigation interval and plant densities on sunflower 1000 seed weight (g) of sunflower grown under drip irrigation system in the Nile Delta in 2007 growing season.

Plant density (D)	Irrigation interval (I)				
	I_1	I_2	I_3	I_4	I_5
D_1	64.433a	73.067a	67.567a	59.933ab	57.833a
D_2	72.767a	60.967a	57.767ab	67.267a	57.767a
D_3	63.200a	57.100a	57.833ab	55.333ab	56.700a
D_4	61.933a	64.567a	47.233b	48.800b	47.567a
D_5	64.100a	67.600a	55.533ab	47.433b	52.633a
I – mean	65.287	64.660	57.187	55.753	54.500

CV (a) = 11.1% CV (b) = 15 .5 % .

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Table 9: Interaction effect between irrigation intervals and plant densities on 1000 seed weight (g) in 2007 growing season.

Plant density (D)	D – mean
D_1	64.567a
D_2	63.307a
D_3	58.033ab
D_4	54.020b
D_5	57.460 ab
I – mean	59.477

Comparison	SED	LSD 5%	LSD 1%
2 – I means at each D	7.137	14.655	19.828
2- D means at each I	7.514	15.187	20.322
2- D means	3.360	6.792	9.088
2- I means	2.402	5.539	9.058

Table 10: Effect of irrigation intervals and plant densities on 1000 seed weight (g) of sunflower grown under drip irrigation system in the Nile Delta in 2008 growing season.

Plant density (D)	Irrigation interval (I)				
	I_1	I_2	I_3	I_4	I_5
D_1	74.167a	67.167a	62.900a	60.000a	52.867a
D_2	62.267b	65.567a	61.500a	57.367ab	54.867a
D_3	64.000bc	64.500a	60.800a	57.000ab	54.700a
D_4	63.800bc	63.200a	58.867a	54.300b	53.067a
D_5	60.233c	57.133b	54.830b	54.100	53.100a
I – mean	65.493	63.513	59.779	56.553	53.720

CV (a) = 6.7 % CV (b = 4.0%

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Table 11: Interaction effect between irrigation intervals and plant densities on 1000 seed weight (g) of sunflower in 2008 growing season.

Plant density (D)	D – mean
D_1	63.420
D_2	60.913
D_3	60.200
D_4	58.647
D_5	55.879
I – mean	59.812

Comparison	S.E.D	LSD 5%	LSD 1%
2 – I means at each D	2.274	4.867	6.768
2- D means at each I	1.940	3.920	5.246

Head diameter (cm)

Data in Tables (12 through 15) clearly showed that under all plant densities the mean values were greatly affected by irrigation intervals where the highest mean values were obtained under the shortest irrigation interval every 4 days in the two growing seasons and the highest mean values were 19.07 and 17.47 cm in the first and second growing seasons respectively. On the other hand, the lowest mean values were recorded under the longest irrigation interval every 20 days and the mean values were 15.45 and 15.36 cm in the first and second growing seasons, respectively. These results are in a great harmony with those obtained by Jana *et. al.* (1982) who found that irrigation increased head diameter. Also, these results are in a great agreement with those obtained by Omer *et al.* (2008).

Concerning the effect of plant densities on head diameter, the results in the same tables the mean values of head diameter were increased under the lowest plant density (one plant at each dripper) comparing with the other plant densities, where the highest mean values were 21.67 and 19.0 cm in the first and second growing seasons, respectively.

Table 12: Effect of irrigation intervals and plant densities on head diameter of sunflower under drip irrigation system in the Nile Delta in 2007 growing season.

Plant density (D)	Irrigation interval (I)				
	I_1	I_2	I_3	I_4	I_5
D_1	21.667a	18.433a	19.967a	17.200a	17.267a
D_2	19.900ab	18.667a	18.000ab	15.433a	16.300a
D_3	21.233a	18.800a	18.200ab	14.900a	14. 200a
D_4	17.333bc	18.100a	15.733b	15.000a	14.567a
D_5	15.233c	19.567a	17.900ab	14.900a	14.900a
I – mean	19.073	18.713	17.960	15.487	15.447

CV (a) = 107% **CV (b) = 11.7%**

In a column means followed by a common letter are not significantly different at the 5% level by DMRT

Table 13: Interaction effect between irrigation intervals and plant densities on head diameter in 2007growing season.

Plant density (D)	D – mean
D_1	18.907a
D_2	17.660ab
D_3	17.467ab
D_4	16.147b
D_5	16.500b
I – mean	17.33

Comparison	S.E.D	LSD 5%	LSD 1%
2 – I means at each D	1.626	3.366	4.500
2- D means at each I	1.654	3.342	4.472
2 – D means	0.740	1.495	2.000
2- I means	0.676	1.558	2.267

Table 14: Effect of irrigation intervals and plant densities on head diameter of sunflower grown under drip irrigation system in the Nile Delta in 2008 growing season.

Plant density (D)	Irrigation interval (I)				
	I_1	I_2	I_3	I_4	I_5
D_1	19.000a	17.933a	17.000a	16.167ab	15.600a
D_2	17.700ab	17.067ab	16.067a	16.933a	15.500a
D_3	17.833ab	17.400ab	17.267a	16.733a	15.967a
D_4	16.000b	15.600b	17.333a	14.100b	14.900a
D_5	16.800ab	16.000ab	16.067a	15.667ab	14.833a
I – mean	17.467	16.800	16.747	15.920	15.360

CV (a) = 8.3% **CV (b) = 7.5%**

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Table 15: Interaction effect between intervals and plant density on head diameter of sunflower in 2008 growing season .

Plant density (D)	D – mean
D_1	17.140a
D_2	16.653ab
D_3	17.040a
D_4	15.587c
D_5	15.873
I – mean	16.459

Comparison	S.E.D	LSD 5%	LSD 1%
2 – I means at each D	1.034	2.159	2.954
2- D means at each I	1.011	2.043	2.734
2- D means	0.452	0.914	1.222
2- I means	0.501	1.156	1.682

Plant height

Data in Tables (16 through 20) clearly demonstrated that the mean values of plant height were greatly affected by irrigation intervals under the same plant densities where the highest mean values were recorded under treatment of 12 days between irrigations in the first growing season and 8 days in the second season and the mean values were 157.37 and 167.53 cm in the first and second growing seasons, respectively. These findings agree with that of Al- Ghamad *el .al* . (1991) who found that water depletion significantly affected plant height which decreased by increasing soil moisture depletion. Also, these results are in a great agreement with those obtained by Omer *et al.* (2008).

Table 16: Effect of irrigation intervals and plant densities on plant height of sunflower grown under drip irrigation system in the Nile Delta in 2007 growing season.

Plant density (D)	Irrigation interval (I)				
	I_1	I_2	I_3	I_4	I_5
D_1	157.467bc	156.000b	149.033b	152.900a	139.000a
D_2	155.567c	158.100b	148.200b	152.100a	145.733a
D_3	172.400ab	168.333ab	168.967a	152.700a	145.433a
D_4	183.100a	176.800a	168.233a	157.833a	146.767a
D_5	161.900bc	178.433a	167.433a	153.267a	135.967a
I – mean	166.087	167.533	160.373	153.760	142.580

CV (a) = 7.7 % **CV (b) = 5.9 %**

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Concerning the effect of plant densities on plant height there wasn't any clear relationship between plant density and plant height but, generally the highest mean values were achieved under high plant densities.

Table 17: Effect of irrigation intervals and plant densities on plant height of sunflower grown under drip in 2008 growing season.

Plant density (D)	D – mean
D_1	150.880b
D_2	151.940b
D_3	161.567a
D_4	166.547a
D_5	159.400a
I – mean	158.067

Comparison	S.E.D	LSD 5%	LSD 1%
2 – I means at each D	8.150	17.161	23.616
2- D means at each I	7.637	15.436	20.655
2- D means	3.416	6.903	9.237
2- I means	4.444	10.249	14.909

In a column, means followed by a common letter are not significantly at the 5% level by DMRT.

Table 18: Interaction effect between irrigation intervals and plant density on plant height of sunflower in 2008.

Irrigation (I)	I – mean
I_1	151.087a
I_2	152.707a
I_3	157.367a
I_4	149.407a
I_5	148.878a
D– mean	1510888

Table 19: Effect of irrigation intervals and plant densities on plant height of sunflower grown under drip irrigation system in the Nile Delta in 2008 growing season.

Plant density (D)	Irrigation (I)				
	I_1	I_2	I_3	I_4	I_5
D_1	143.000b	149.800a	161.567a	147.133a	146.767a
D_2	148.600ab	148.867a	154.333a	152.300a	148.300a
D_3	151.800ab	150.967a	154.267a	153.533a	148.867a
D_4	153.833ab	153.367a	153.000a	141.767a	149.567a
D_5	158.200a	160.533a	163.663a	152.300a	150.867a
I – mean	151.087	152.707	157.367	149.407	148.873

CV (a) = 15.1% **CV (b) = 5.4 %**

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Table 20: Interaction effect between irrigation intervals and plant density on plant height of sunflower in 2008.

Plant density (D)	D – mean
D_1	149.653 b
D_2	150.480b
D_3	151.887ab
D_4	150.307b
D_5	157.113a
I – mean	151.888

Water applied (WI), (m^3/fed)

Sunflower is a summer crop, which grows in Egypt under irrigation conditions because there is no rainfall during summer months in Egypt. Presented data in Table (21) showed that the amounts of water applied were decreased by increasing irrigation intervals where the highest values of water applied were recorded at the shortest irrigation interval every 4 days and the values were 1482.04 and 1556.80 m^3/ fed in the first and second growing seasons, respectively. On the contrary, the lowest values were recorded under the longest irrigation interval every 20 days and the values were 1135.64 and 1110.0 m^3/fed in the first and second growing seasons, respectively.

Data also clearly show that elongation of irrigation interval decreased the amount of water applied, this is preferable to make saving for irrigation water, but there is a great shortage of seed yield where the values of seed yield under the shortest irrigation interval were 1.03 and 1.08 ton /fed, but for the longest interval were 0.56 and 0.58 ton/ fed in the first and second growing seasons under irrigation every 4 days and 20 days, respectively. Increasing amount of water applied under the shortest irrigation interval in comparison with the longest ones may be due to increasing the number of irrigations in comparison with the other treatments. Amounts of water applied in this study are within the range reported by Dubbelde *et. al.* (1982), who concluded that total crop water use for sunflower under semiarid conditions varied from 1033 to 4019 m^3/ feddan. Also, these results are in a great agreement with those obtained by Omer *et al.* (2008).

Table 21: Effect of irrigation intervals and plant densities on amount of water applied during the two growing seasons .

Irrigation interval (day)	Water applied (m^3/fed)	
	2007	**2008**
4	1482.04	1556.80
8	1413.04	1363.60
12	1335.32	1248.80
16	1292.64	1130.00
20	1135.64	1110.00

Water utilization efficiency (kg /m^3)

Data presented in Table (22) showed that the values of water utilization efficiency were clearly affected by irrigation intervals where the highest values were recorded under the shortest irrigation interval every 4 days and the values were 0.67 and 0.71 kg/ m^3 in the first and second growing seasons, respectively. On the other hand, the lowest values where recorded under the longest irrigation interval every 20 days between irrigations and the values were 0.5 and 0.52 kg / m^3 in the first and second growing seasons, respectively.

Table 22: Effect of irrigation intervals and plant densities on water utilization Efficiency during two growing seasons.

Irrigation interval (day)	Water utilization efficiency (W.Ut.E.), kg/ m^3	
	2007	**2008**
4	0.67	0.71
8	0.50	0.57
12	0.52	0.58
16	0.54	0.64
20	0.53	0.52

Oil content

Data in Table (23) clearly showed that the mean values of oil content in sunflower seeds were greatly affected by irrigation interval where the highest mean values were recorded under 16 days between irrigations in the two growing seasons and the highest mean value was 37.513%. Also, data in the same Table illustrated that the mean values for all treatments of irrigation were nearly similar except 16 days treatment it was the highest.

Increasing oil content under 16 days is a good result. So, we recommend that irrigation in this area under study will be every 16 days without any drastic effect on oil content in seeds of sunflower.

Table (23): Effect of irrigation intervals and plant densities on oil content of sunflower seeds under drip irrigation system

Irrigation interval	1st season					2nd season				
	D_1	D_2	D_3	D_4	D_5	D_1	D_2	D_3	D_4	D_5
4 days	36.22	36.34	35.60	36.37	37.32	37.89	36.68	37.28	37.80	37.73
Mean	36.57					37.476				
Total mean	37.023									
8 days	35.88	36.61	35.57	35.61	37.45	37.35	37.89	37.33	37.53	37.69
Mean	36.224					37.558				
Total mean	36.891									
12 days	36.60	37.18	37.24	37.0.4	37.16	36.81	37.90	37.32	37.87	37.80
Mean	37.044					37.54				
Total mean	37.292									
16 days	36.18	37.62	37.19	37.73	36.93	38.00	37.96	37.95	38.07	37.50
Mean	37.13					37.896				
Total mean	37.513									
20 days	37.20	36.59	37.30	36.96	36.37	36.33	37.59	36.88	38.22	37.02
Mean	36.884					37.208				
Total mean	37.046									

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تحديد فترة الري المثلي تحت كثافات نباتيه مختلفة لمحصول عباد الشمس تحت نظام الرى بالتنقيط في منطقة شمال وسط الدلتا.

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أجريت تجربتين حقليتين تحت نظام الرى بالتنقيط في المزرعة البحثية بمحطة البحوث الزراعية بسخا – محافظة كفر الشيخ خلال موسمي الدراسة 2007 ، 2008. وكان الهدف الرئيسي من هذه التجربة هو دراسة تأثير فترات الرى والكثافة النباتية على انتاجية عباد الشمس ، وكذلك بعض العلاقات المائية والخصائص التكنولوجية وجودة المحصول .

ويمكن تلخيص البيانات المتحصل عليها فيما يلي :

- زاد محصول البذور بصورة واضحة بنقص فترة الرى حيث سجلت أعلى متوسطات للقيم مع الري كل 4 أيام وكانت القيم 1.03 ، 1.08 طن/ فدان (2.45 ، 2.57 طن/ هكتار) في الموسم الأول والثاني على الترتيب. كذلك أوضحت النتائج انه لا توجد فروق واضحة بين فترات الري كل 8 ، 12 ، 16 يوم حيث كانت القيم الى حد ما متشابهة ولكن مع فترة الري كل 20 يوم حيث تناقصت القيم بشكل واضح.
- زادت متوسط القيم لوزن الـ 1000 بذرة مع الري كل 4 يوم بالمقارنة بباقى الفترات 8 ، 12 ، 16 ، 20 يوم ، حيث كانت أعلى المتوسطات للقيم 65.287 ، 65.493 جرام في الموسم الأول والثاني على الترتيب وعلى العكس من ذلك سجلت أقل القيم مع الري كل 20 يوم بين الريات.
- بالإضافة الى ذلك أوضحت النتائج تناقص متوسط القيم لقطر القرص بزيادة فترة الرى حتى 20 يوم. أعلى متوسطات للقيم بالنسبة من الصفه الدراسة سجلت مع الري كل 4 أيام بين الريات وكانت قيمة قطر القرص 19.073.
- سجلت أعلى المتوسطات بالنسبة لطول النبات مع فترة الرى كل 8 يوم في الموسم الأول، 12 يوم في الموسم الثاني، وكانت متوسطات القيم 167.533 ، 157.367 سم على الترتيب وعلى الجانب الأخر أوضحت البيانات انه لا توجد علاقة ثابتة واضحة بين الكثافات النباتية وعناصر الدراسة .
- أيضاً أوضحت الدراسة ان إطالة فترة الرى أدت الى نقص كمية المياه المضافة حيث سجلت أعلى القيم مع الري كل 4 أيام بين الريات وكانت القيم 1482.04 ، 1556.8 م^3/فدان في الموسم الأول والثاني على الترتيب. وعلى العكس من ذلك سجلت أقل القيم مع الري كل 20 يوم بين الريات وكانت القيم 1135.64 ، 1110.0 م^3/فدان في الموسم الأول والثاني على الترتيب .
- تأثرت كفاءة استخدام المياه بصورة ملحوظة بفترات الرى حيث سجلت أعلى القيم مع الري كل 4 أيام بين الريات حيث كانت 0.67 ، 0.71 كجم/ م^3 فى الموسم الأول والثاني على الترتيب ولكن مع الرى كل 8 ، 12 ، 16 ، 20 يوم كانت القيم أقل بالمقارنة بالفترة الأولى 4 أيام بين الريات ولم يكن هناك علاقة ثابتة وواضحة بين فترات الرى الأخرى 8 ، 12 ، 16 ، 20 يوم .
- أوضحت النتائج كذلك أن اعلى القيم بالنسبة لمحتوى الزيت سجلت تحت المعاملة 16يوم بين الريات مقارنة بباقي المعاملات موضع الدراسة.

قام بتحكيم البحث

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