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Impact of deficit irrigation at different growth stages on some sesame varieties in Upper Egypt

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ABSTRACT

Two field experiments were carried out at Shandaweel during 2005 and 2006 seasons to study the effect of deficit irrigation at different growth stages [i.e. Branching stage (I_1), Flowering stage (I_2), Capsule development stage (I_3) and control (I_4)] using four sesame varieties [i.e. Giza32 (V_1), Toshky1 (V_2), Shandaweel3 (V_3) and Sohag1 (V_4)]. The effect of the previously mentioned factor on yield, yield components, oil yield and some water relations were studied.

Results indicated that number of capsules/ plant, length of fruiting zoon (cm), seed weight /plant (g), 1000-seed weight (g), seed yield (kg/ fed), and oil yield (kg/ fed) were significantly affected by the irrigation treatments. The highest values were obtained for I_3 treatment except length of fruiting zoon (cm) which was increased for I_4 treatment. Shandaweel3 (V_3) was superior in seed yield in 2005 season by 34.90, 7.90 and 10.30 % as compared with V_1, V_2 and V_4, respectively. However, in 2006 the respective increase in seed yield reached about 54.30, 5.60 and 5.90 %. The best interaction effect was found for I_3 with V_3. Giza32 variety was superior in oleic acid and Sohag1 variety gave the maximum value in omega-6 as compared with the other varieties.

Water consumptive use or evapotranspiration (ETcrop) in 2005 season was 2528, 2440, 2466 and 2932 m^3/ fed for I_1, I_2, I_3 and I_4 treatments, respectively. The respective values in 2006 were 2639, 2549, 2565 and 3052 m^3/ fed. The highest ETcrop was found for I_4 in both seasons, while, I_2 treatment showed the minimum value.

With respect to varieties, values of ETcrop in 2005 were 2795, 2479, 2524 and 2569 m^3/ fed, for V_1, V_2, V_3 and V_4, respectively. However, in 2006, the respective values were 2893, 2591, 2637 and 2684 m^3/ fed. The variety of V_1 registered the highest ETcrop in both seasons; however, V_2 variety gave the lowest one followed by V_3. The variety V_2 saved irrigation water about 11.3, 1.9 and 3.5 % in 2005 and 10.4, 1.7 and 3.5 % in 2006 as compared with V_1, V_3 and V_4, respectively. The interaction between I_4 with V_1 gave the highest ETcrop, however, the lowest ETcrop was found for the interaction of I_2 with V_2 in both seasons.

Crop water productivity (CWP) was increased for I_3 treatment compared with the other irrigation treatments under study. At the same time, V_3 gave the highest CWP, while, V_1 gave the lowest one in both studied seasons. The interaction between I_4 with any variety registered minimum values of CWP. While, I_3 with any variety gave maximum ones. The best interaction was found for I_3 with V_3.

It can be concluded that subjecting sesame plants to long interval days between irrigations at capsule development stage encourage the plants to give more number of capsules, increase in seed weight/ plant and increase in seed yield/ fed accordingly. Shandaweel3 (V_3) is more tolerant to water deficit as compared with the other varieties under study, while, Giza32 is the most vulnerable. Also, flowering stage is more sensitive stage to water deficit, while, capsule development stage is more tolerant in the life of sesame plants.

INTRODUCTION

In Egypt, oil production covers only about 5 % of the annual requirements, which is far from self-sufficiency. Thus, it is necessary to increase the yield of commercial cultivars, in order to narrow the gap between production and consumption. Sesame (*Sesamum indicum L*.) is one of the ancient cultivated oil crops in Egypt as it was a major oilseed in the ancient world for its ease of extraction. More over sesame drought tolerant and can withstand high heat, but as with all crops, sesame will have higher yields under irrigation**.**

Omega-6 (linoleic) acid is generally recognized as the essential fatty acid. It is required in the diets of animals and humans, because they are unable to produce it. They are able, however, to convert omega-6 to arachidonic acid and other members of the linoleic or omega-6 family of fatty acids. These long-chain, highly unsaturated fatty acids are important in membrane structures and as starting materials for the synthesis of hormone-like substances, such as prostaglandin's and thromboxanes, (Canola Council of Canada 1988).

Sesame area under cultivation in Egypt in 2008 was about 66354 fed (Agricultural Economic Research Institute Bulletins, Volume 2009), and the production was 36455 ton (average productivity per fed was 0.55 ton).

In this connection Rao and Raju (1991) studied in field trail, 7 irrigation treatments designed to give moderate or severe evapotranspiration deficits (ETd) at vegetative, reproductive or ripening growth stages. They found that seed yield decreased with increasing water stress and lowest with ETd at the reproductive stage (0.56 t/ ha). Methew and Kunju (1993) showed that sesame seed yield increased with increasing number of irrigation.El-Serogy *et al.* (1997) and Metwally *et al.* (1984) indicated that seed oil percentage increased with increasing water availability to the crop. El-Emery *et al*. (1997) studied the influence of irrigation number and harvesting date on the quality of sesame seeds of four genotypes. They indicated that weight of 1000 seeds and seed yield/ fed were improved by increasing the number of irrigation from 5 to 6 times (15 day intervals). El-Serogy *et al* (1998) determined the optimal time of terminal irrigation and harvesting date of some sesame varieties. They indicated that higher growth measurements of sesame were recorded from 6 irrigations and harvesting after 105 days from sowing. They added that water use efficiency was increased by 6 irrigation, delaying harvest date for Giza32 variety from 90 to 105 days after sowing in both seasons. El-Tantawy *et al*. (2003) found that average actual evapotranspiration (ETa) values varied between 38.17 and 47.30 cm/ fed. The ETa values increased with decreasing interval between irrigations. Dikshit and Swain (2000) found that the maximum seed oil content were 67.6%. Raheja *et al*. (1989) and El-Shakhess *et al*. (2008) found that oil content ranged from 46.2 to 56.8%. Palmitic acid varied from 9.53 to 14.59%, stearic acid 3.50 to 6.82%, oleic acid 39.96 to 48.28% and an omega-6 29.97 to 45.11%.

The aim of the present investigation is to study the impact of deficit irrigation at different growth stages on quantity and quality of some sesame varieties production and determined the stages that are more tolerant to water deficit in each one. Also, impact of deficit irrigation on crop water use and crop water productivity will be examined in the present study.

MATERIALS AND METHODS

Two field experiments were carried out in Shandaweel (Sohag Governorate), Egypt, during 2005 and 2006 seasons to study the effect of water deficit at different growth stages on seed yield of some sesame varieties, yield components, oil yield, and some water relations.

Spilt plots design with three replicates was used. The plot area was 1/100` fed. The main plots were devoted to irrigation treatments and the sub plots were allocated the four sesame varieties. All agronomic practices were applied as the recommended for the area under study. Sowing date was in May 17th and 18th in 2005 and 2006 seasons respectively. The preceding crop to sesame was wheat in the two studied seasons.

The description of the experimental treatments were as follows:

Main plots: Irrigation treatments:

1- I_1: Withholding irrigation at branching stage (45th day after sowing).
2- I_2: Withholding irrigation at flowering stage (60th day after sowing).
3- I_3: Withholding irrigation at capsule development stage (90th day after sowing).
4- I_4: Control (irrigation each 15 days).

Sub-plots: Sesame varieties:

1- V_1: Giza32 variety.
2- V_2: Toshky1 variety.
3- V_3: Shandaweel3 variety.
4- V_4: Sohag1 variety.

The soil moisture constants and agro- meteorological data at Shandaweel Agricultural Research Station are shown in Table 1 and 2, respectively. Table 3 indicates date of sowing and harvesting for different varieties through the two successive seasons.

Table 1: Soil moisture constants at Shandaweel area (Sohag Governorate).

Soil Depth (cm)	Field Capacity %	Welting Point %	Available Water %	Bulk Density (g/ cm^3)
01 - 15.	35.04	14.45	20.59	1.26
15 - 30.	31.21	13.90	17.31	1.30
30 - 45.	27.11	13.09	14.02	1.34
45 - 60.	27.85	12.69	15.16	1.35

Table 2: Meteorological data at Shandaweel Agricultural Research Station in 2005 and 2006 seasons.

Month	T.max.	T.min.	W.S	R.H	S.S	S.R
	2005					
May	35.0	18.2	2.2	56	11.3	604
June	38.0	22.2	2.2	47	12.3	638
July	37.4	21.8	1.9	58	12.2	630
August	36.3	20.9	1.9	57	11.9	608
September	35.2	18.3	2.3	57	10.8	540
	2006					
May	34.9	19.0	2.2	34	11.3	604
June	38.5	22.6	2.2	39	12.3	638
July	36.2	20.7	1.9	56	12.2	630
August	36.1	21.4	1.9	56	11.9	608
September	35.9	11.7	2.3	57	10.8	540

where: T.max., T.min. = maximum and minimum temperatures °C; W.S = wind speed (m/ sec); R.H. = relative humidity (%); S.S = actual sun shine (hour); S.R = solar radiation (cal/ cm^2/ day).

Table 3: Date of sowing and harvesting for different varieties used in the trail during 2005 and 2006 seasons.

Characters		Sowing date		Harvesting date	
Irri.	**Var.**	**2005**	**2006**	**2005**	**2006**
I_1	V_1	17/5/2005	18/5/2006	26/9	28/9
	V_2			12/9	15/9
	V_3			15/9	17/9
	V_4			18/9	21/9
I_2	V_1	17/5/2005	18/5/2006	19/9	21/9
	V_2			05/9	07/9
	V_3			07/9	07/9
	V_4			12/9	15/9
I_3	V_1	17/5/2005	18/5/2006	09/9	10/9
	V_2			31/8	01/9
	V_3			01/9	02/9
	V_4			04/9	09/9
I_4	V_1	17/5/2005	18/5/2006	27/9	28/9
	V_2			13/9	15/9
	V_3			15/9	17/9
	V_4			17/9	19/9

Note: In this Table and other Tables
I_1 = withholding irrigation at the 45th days after sowing.
I_2 = withholding irrigation at the 60th days after sowing.
I_3 = withholding irrigation at the 90th days after sowing.
I_4 = control (irrigation each 15 days).
V_1 = Giza32, V_2 = Toshky1, V_3 = Shandaweel3 and V_4 = Sohag1

CHARACTERS STUDIED:

Yield and yield components:

1. Number of capsules/ plant.
2. Length of fruting zoon (cm).
3. Seed weight/ plant (g).
4. 1000-seed weight (g).
5. Seed yield (kg/fed).

Oil yield:

Seed samples were collected from each sub-plot to determine seed oil percentage according to the Standard Methods of A.O.A.C. (1990), using Soxlhlet apparatus and hexane as solvent.

Determination of fatty acids:

Methylation of the triglycerieds content of the crude extracted oils was carried out using methanolic base (0.5 N) in iso-octane at room temperature as reported by Daun *et al*. (1983). The methylated fatty acids samples were analyzed by GLC technique using Hewlett Packard, HP-5890 Plus 11 with flame ionization detector (FID) supplied with integrator and computer control under the following conditions:

Column HP 20 M (Carbowax), 25 M length, 0.3 mm inside diameters, 0.3-μm-film thickness. Column temperature 170^{o}C and head pressure 3.5 psi. Carrier gas N, 30 ml and flow rate 2.0 ml/min. Injection port temperature 220^{o}C and detector temperature 250^{o}C.

Standard methyl ester of the fatty acids was used for identification of the unknown fatty acid and calculated as area percent under scale.

Water Consumptive Use

Water consumptive use or Evapotranspiration (ET crop) was determined using a computer program named CROPWAT4.3 model (Derek *et al*., 1998). Water consumptive use was estimated for different varieties under skipping irrigation at different growth stages.

Data needed for CROPWAT4.3 model:

The data needed are:

1- Climate Information.
2- Crop Informations.
3- Soil Information.

Climate Information

Mean monthly temperature (minimum and maximum), humidity, sunshine and wind speed data in 2005 and 2006 seasons were collected for the study area (from: Agro- meteorology and Climate Change Unit, Soil, Water & Environment Res. Institute, SWERI, ARC, and Ministry of Agriculture, unpublished data).

Crop Information

Crop information including pattern %.

Crop coefficient, growth stages, sowing and harvesting data for each variety.

Crop information data for each variety are listed in Table 4.

Soil Information

Total available soil moisture (mm/m depth), maximum infiltration rate (mm/day), maximum rooting depth (m) and initial soil moisture depletion (% of total available moisture). Relevant soil characteristics at Shandaweel area are described in Table 5.

Table 4: Crop Coefficient, growth stages, sowing and harvesting date for control irrigation treatment with sesame varieties under study.

Crop	Crop Coefficient (Kc)			Growth Stages (day)				Sowing Date		Harvesting Date	
	1	2	3	1	2	3	4	2005	2006	2005	2006
Giza 32 (V_1)	0.35	1.15	0.6	20	35	40	25	May-17	May-18	Sep. 27	Sep. 28
Toshky 1 (V_2)	0.35	1.15	0.6	20	35	40	25	May-17	May-18	Sep. 13	Sep. 15
Shandaweel 3 (V_3)	0.35	1.15	0.6	20	35	40	25	May-17	May-18	Sep. 15	Sep. 17
Sohag 1 (V_4)	0.35	1.15	0.6	20	35	40	25	May-17	May-18	Sep. 17	Sep. 19

Table 5: Relevant soil characteristics (soil retention capacity) at Shandaweel area.

Soil Description	
Total available soil moisture (mm/ m depth)	131
Maximum infiltration rate (mm/ day)	40
Maximum rooting depth (m)	2
Initial soil moisture depletion	50

Crop Water Productivity

According to Smith (2002), Crop water productivity is defined as Crop yield/Water consumptively used in ET. Crop water productivity was done to determine the superior varieties in the return of seeds from water unit (i.e. kg seeds/ m^3 water consumption) under the conditions of the study area.

Statistical analysis:

Data were statistically analyzed according to Snedecor and Cochran (1980). Average values from the three replicates of each treatment were interpreted using the analysis of variance (ANOVA).

RESULTS AND DISCUSSION

1.Yield and yield component:

Number of capsules/ plant, length of fruiting zoon (cm), seed weight/ plant (g), 1000-seed weight (g) and seed yield (kg/ fed) were significantly affected by different irrigation treatments, (Tables 6 and 7). The maximum values were obtained for I_3 treatment in both studied seasons except length of fruiting zoon (cm) which was increased for I_4 treatment. The application of I_3 treatment (withholding irrigation at the 90^{th} day after sowing) increased sesame yield by 5.10, 24.10 and 44.30 % as compared with I_1, I_2 and I_4 ones, respectively in the first season. In the second season, the corresponding increases were 6.10, 38.90 and 37.00 %. It could be concluded that subjecting sesame plants to water deficit (or long intervals between irrigations) at capsule development stage (at 90 days after sowing) is more efficient to encourage the plants to give more seeds and increase in seed weight/ plant. These results are full agreement with those obtained by Ghosh *et al*. (1997), they found that among irrigation treatments, seed yield was the highest (0.76 t/ ha) with irrigations at branching, flowering and pod development (30, 50 and 70 days after sowing).

Table 6: Number of capsules / plant, length of fruiting zoon and seed weight / plant for some sesame varieties as affected by withholding irrigation at different growth stages in 2005 and 2006 seasons.

Treatments	Characters	No. of Capsules /plant		Length of fruiting zoon (cm)		Seed weight/ plant (g)	
Season		2005	2006	2005	2006	2005	2006
Irri.	Var.						
I_1	V_1	65.75	107.50	134.50	151.25	14.75	15.85
	V_2	225.00	246.25	176.25	168.75	22.43	22.38
	V_3	290.25	255.00	162.75	166.25	22.13	25.38
	V_4	163.70	191.25	172.00	180.00	21.22	22.75
	Average	196.19	200.00	161.38	166.56	20.14	21.59
I_2	V_1	57.00	87.50	125.00	150.00	11.13	15.38
	V_2	157.25	200.00	152.50	152.00	19.10	20.75
	V_3	192.25	240.00	163.50	162.50	20.20	22.15
	V_4	141.25	175.00	146.25	156.25	18.60	18.25
	Average	136.94	175.63	146.81	155.31	17.32	19.13
I_3	V_1	92.75	115.00	139.25	160.00	14.43	16.50
	V_2	245.00	246.25	176.00	176.25	25.58	27.38
	V_3	283.25	250.00	181.25	183.75	27.23	29.88
	V_4	168.25	183.75	167.50	186.25	25.98	25.73
	Average	200.25	198.75	166.00	176.56	23.31	24.87
I_4	V_1	67.75	77.50	146.25	170.00	10.28	12.85
	V_2	194.5	180.00	188.75	181.25	18.80	20.50
	V_3	212.5	218.75	193.50	191.25	19.88	21.00
	V_4	150.25	152.50	176.75	185.00	18.88	18.50
	Average	161.75	157.19	176.31	181.88	16.96	18.21
Average for all varieties	V_1	70.81	96.88	136.25	157.81	12.69	15.15
	V_2	205.44	218.13	173.38	169.69	21.48	22.75
	V_3	244.56	240.94	175.25	175.94	22.36	24.60
	V_4	155.88	175.63	165.63	176.88	21.73	21.31
	Average	169.17	182.89	162.62	180.88	19.57	20.95
LSD at 5%	**Irr.**	**8.50**	**3.83**	**4.30**	**3.93**	**0.71**	**0.58**
	Var.	**8.50**	**3.83**	**4.30**	**3.93**	**0.71**	**0.58**
	Irr.xVar.	**37.32**	**28.14**	**17.50**	**14.99**	**5.63**	**4.02**

Regarding varieties, it is clear that they significantly different seed yield. The maximum values were obtained for V_3 (Shandaweel3 CV.). The increase in seed yield for V_3 in 2005 reached about 34.90, 7.90 and 10.30 % as compared with V_1, V_2 and V_4, respectively. However, in 2006 the respective increase in seed yield using V_3 reached about 54.30, 5.60 and 5.90 %. Results indicated that the climatic conditions at Shandaweel area is favorable for growing Shandaweel3 variety as compared with the other varieties. Increasing seed yield for Shandaweel3 could encourage farmers to used this variety studied as well as increasing sesame area.

Significant interaction effects were found between irrigation treatments and sesame varieties for number of capsules/ plant, length of fruiting zoon (cm), seed weight/ plant (g), 1000-seed weight (g) and seed yield (kg/ fed) The best interaction effect was register for the treatment I_3 with the variety V_3.

From the previous results, it could be seem that Shandaweel3 is recorded the tolerant variety to water deficit as compared with the other varieties under study. At the same time, flowering stage is the most sensitive stage to water deficit and capsule development is the most tolerant stage to water deficit for sesame plants.

Oil yield:

Results as presented in Table 7 indicated that oil yield was significantly affected by irrigation deficit in the two seasons. The maximum values were obtained for I_3 **(**withholding irrigation at the 90^{th} day after sowing). These results may be due to subjecting sesame plants to water deficit especially during translocation of the sugars from the leaves to seeds, increase seed oil content. Increasing oil yield in 2005 for I_3 treatment reached about 2.8, 23.9 and 42.7 % as compared with I_1, I_2 and I_4 treatments, respectively.

However, the respective increases in 2006 were 7.4, 29.3 and 35.8 %. In this connection, Dutta *et al.* (2000) studied response of summer sesame to different levels of irrigation. Treatments comprised: one irrigation at the branching stage; two irrigations (one each at branching and capsule-development stages and three irrigations (one each at the branching, flowering and capsule-development stages). They found that sesame (*S. indicum*) increase in the levels of irrigation from 1 to 3 increased all growth attributes and yield components. Three irrigations, one each applied at branching, flowering and capsule-development stages recorded the highest yield (seed and oil), followed by two irrigations (branching and flowering).

With respect to varieties, oil yield was significantly affected by sesame varieties. Shandaweel3 variety was superior in the two successive seasons. While, the variety of Giza32 give the lowest oil yield in both seasons. The interaction between irrigation treatments and sesame varieties significantly affected oil yield. The best interaction was found for I_3 with V_3.

Fatty acid compositions%

A low level of saturated fatty acids, a relatively high level of the monounsaturated fatty acid, oleic acid, and polyunsaturated fatty acid, an omega-6, characterizes sesame oil.

Table 8 showed that the fatty acids were predominant in the four sesame varieties, palmitic, stearic, oleic, omega-6, omega-3 and arachidic. The total unsaturated fatty acids ranged from 85.16% to 86.63%. Meanwhile, total saturated fatty acids ranged from 13.46% to 14.86%. The maximum value of oleic acid (44.62%) was obtained for Giza32. However, the lowest one (38.78%) was registered for Sohag1. At the same time, the last one gave the highest value of omega-6 (45.90%). These results are in good agreement with those obtained by Reheja *et al*. (1989) and El-Emery *et al*. (1997).

Predominant fatty acids comprised palmitic, stearic, arachidic, oleic, omega-6 and omega-3 ranged from (8.72-9.73%), (4.40-5.27%), (0.00-0.31%), (38.78-44.62%), (40.34-45.90%)and (0.27-0.48%), respectively. Similar results were recorded by El-Shakhess *et al*. (2003 and 2008) and El-Samanody *et al*. (2004) who found that predominant fatty acids comprised palmitic, stearic, arachidic, oleic, omega-6 and omega-3 ranged from (7.69-14.54%), (3.40-7.52%), (0.00-3.40%), (38.30-45.72%), (35.15-45.13%) and (0.00-1.17%), respectively.

Table 7: 1000-seed weigh, seed yield/ fed and oil yield/ fed for some sesame varieties as affected by withholding irrigation at different growth stages in 2005 and 2006 seasons.

Treatments	Characters	1000-seed weight (g)		Seed yield (kg/fed)		Oil yield (kg/fed)	
	Season	2005	2006	2005	2006	2005	2006
Irri.	Var.						
I_1	V_1	3.70	3.98	490.75	425.25	254.93	234.73
	V_2	4.65	4.38	584.50	818.75	310.08	429.03
	V_3	4.80	4.48	616.75	863.75	336.18	457.83
	V_4	4.73	4.30	590.00	807.50	344.28	427.00
	Average	4.47	4.29	570.50	735.56	311.36	387.56
I_2	V_1	4.03	4.05	401.25	469.25	209.25	239.15
	V_2	4.53	4.23	491.00	589.50	266.03	306.15
	V_3	4.58	4.35	549.50	604.25	296.73	427.20
	V_4	4.68	4.33	489.75	583.50	261.10	314.90
	Average	4.46	4.24	482.88	561.63	258.28	321.85
I_3	V_1	4.03	4.25	475.25	597.25	250.33	311.05
	V_2	4.60	4.70	619.50	824.50	328.33	349.78
	V_3	4.70	4.78	700.00	877.50	377.90	475.23
	V_4	4.96	4.60	603.75	805.00	324.48	428.93
	Average	4.57	4.58	599.63	780.56	320.26	416.24
I_4	V_1	4.00	3.95	347.75	419.75	184.50	218.90
	V_2	4.73	4.15	450.00	581.25	243.05	311.65
	V_3	4.83	4.30	448.50	647.50	246.68	351.40
	V_4	4.80	4.30	415.00	630.00	223.35	343.40
	Average	4.59	4.18	415.31	569.63	224.39	306.37
Average for all varieties	V_1	3.94	4.06	428.75	484.63	224.72	250.96
	V_2	4.63	4.37	536.25	708.00	286.87	374.15
	V_3	4.73	4.45	578.69	748.25	314.39	427.94
	V_4	4.79	4.38	524.63	706.50	288.30	378.56
	Average	4.52	4.31	517.08	661.85	278.58	357.90
LSD at 5%	**Irr.**	**0.09**	**0.08**	**21.02**	**9.90**	**11.95**	**2.95**
	Var.	**0.09**	**0.08**	**21.02**	**9.90**	**11.95**	**2.95**
	Irr.xVar.	**0.32**	**0.20**	**68.19**	**72.29**	**45.17**	**41.21**

Table 8: Fatty acids composition % of the four sesame varieties.

Component	Varieties			
	Giza32	**Toshky1**	**Shandaweel3**	**Sohag1**
Palmitic C16:0	9.11	9.06	8.72	9.73
Stearic C18:0	5.27	4.40	4.61	4.82
Arachidic C20:0	0.12	0.00	0.23	0.31
Oleic C18:1	44.62	41.30	41.15	38.78
Omega-6	40.34	44.86	45.21	45.90
Omega-3	0.34	0.31	0.27	0.48
TS*	14.50	13.46	13.56	14.86
TU**	85.31	86.47	86.63	85.16
TU/TS	5.89	6.42	6.39	5.73

*** TS=Total Saturated Fatty acids**
**** TU=Total Unsaturated Fatty acids**

Water Consumptive Use

Seasonal water consumptive use or crop evapotranspiration (ETcrop) for sesame varieties under skipping irrigation at different growth stages in 2005 and 2006 seasons are presented in Figs. 1 and 2. The data showed that ETcrop in 2005 were 2528, 2440, 2466 and 2932 m^3/ fed for I_1, $I_{2,}$ I_3 and I_4 treatments, respectively. The respective values in 2006 were 2639, 2549, 2565 and 3052 m^3/ fed. Results indicated that few increases in ETcrop was recorded in the second season as compared with the first season, this may be due to decreasing relative humidity in the second season compared with first one. On the other hand, I_4 treatment (without withholding irrigation) gave the maximum ETcrop in both seasons, while, I_2 treatment (withholding irrigation at 60 days after sowing, at flowering stage) registered the minimum value.

Fig. 1: Water consumptive use for sesame varieties under withholding irrigation at different growth stages in 2005 season.

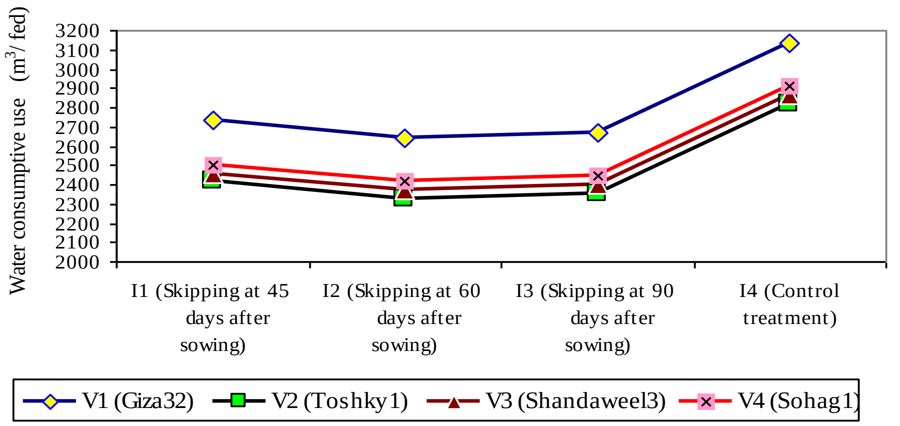
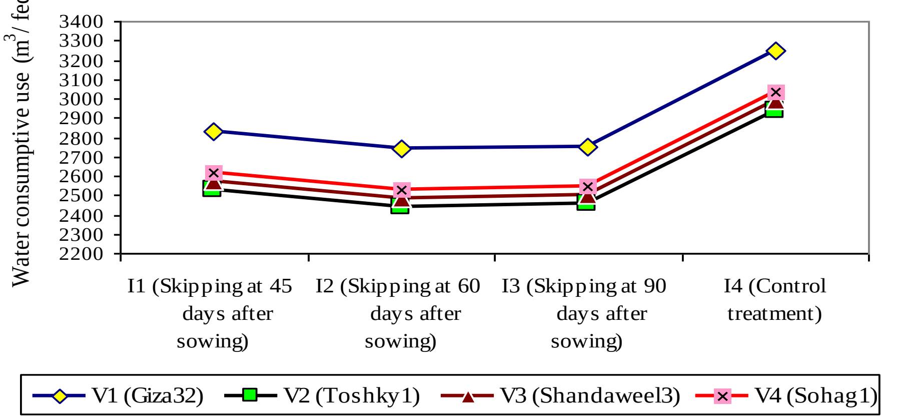


Fig. 2: Water consumptive use for sesame varieties under withholding irrigation at different growth stages in 2006 season.



With respect to varieties, values of ETcrop in 2005 were 2795, 2479, 2524 and 2569 m^3/ fed, for V_1, V_2, V_3 and V_4, respectively. However, in 2006, the respective values were 2893, 2591, 2637 and 2684 m^3/ fed. Results indicate that V_1 variety registered the highest ETcrop in both seasons, however, V_2 gave the lowest one followed by V_3. Variety V_2 saved irrigation water about 11.3, 1.9 and 3.5 % in 2005 and 10.4, 1.7 and 3.5 % in 2006 as compared with V_1, V_3 and V_4, respectively.

The interaction between I_4 with V_1 gave the highest ETcrop, however, the lowest ETcrop was found for the interaction of I_2 with V_2 in both seasons.

Crop Water Productivity (CWP)

Average values of CWP in 2005 were 0.23, 0.20, 0.25 and 0.14 kg seeds/ m^3 water consumption for I_1, $I_{2,}$ I_3 and I_4 treatments, respectively. Values in 2006 were 0.28, 0.22, 0.31 and 0.19 kg seeds/ m^3 water consumption for the same respective irrigation treatments. Results clearly show that withholding irrigation at 90 days after sowing (I_3) resulted in higher CWP compared with the other irrigation treatments under study. This may be due to that withholding irrigation at capsule development stage could save water about 16 % and encourage increas in number of capsules, seeds weight/ plant and seed yield / fed. (Figs. 3 and 4).

With respect to varieties, CWP values in 2005 were 0.16, 0.22, 0.23 and 0.21 kg seeds/ m^3 water consumption for V_1, V_2, V_3 and V_4, respectively. However, the respective values in 2006 were 0.17, 0.28, .29 and 0.27 kg seeds/ m^3 water consumption. It is clear that CWP increased for the variety V_3 followed by V_2 and V_4, while, the variety V_1 (Giza32) gave the lowest CWP in both studied seasons. This is expected as recorded V_1 the highest water consumptive use and the lowest crop productivity.

As for the interaction between irrigation treatments and varieties, results presented in Figs. 3 and 4 indicated that the interaction between I_4 with V_1 gave the lowest CWP as compared with the other interactions. At the same time, I_4 with any variety registered minimum values of CWP, while I_3 for any variety gave maximum value. It could be concluded that withholding irrigation at any stage of growth resulted in higher CWP values compared to the control irrigation treatment. Generally, the best interaction was found for I_3 with V_3.

Fig. 3: Crop water productivity for sesame varieties under withholding irrigation at different growth stages in 2005 season.

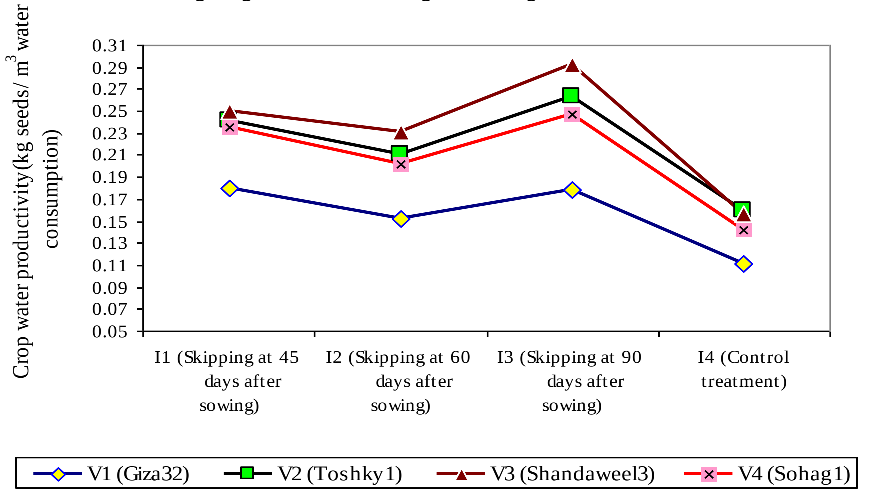
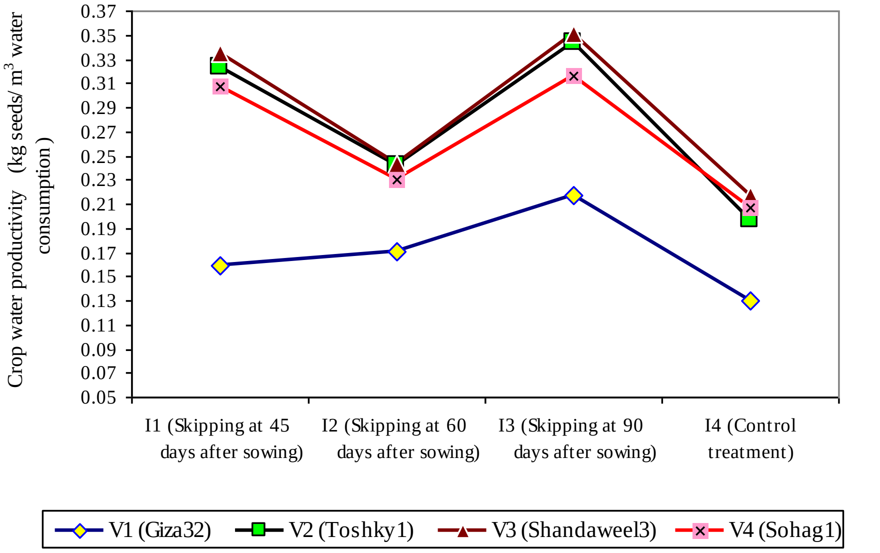


Fig. 4: Crop water productivity for sesame varieties under withholding irrigation at different growth stages in 2006 season.



From all previous results, it can be concluded that irregation intervals for sesame plants each 15 days is not preferable, which subjecting plants to long intervals at capsule development stage encourage the plants to give more number of capsules and increase seed weight/ plant. At the same time, Shandaweel3 (V_3) is more tolerant to water deficit as compared with the other studied varieties with Giza32 as the more vulnerable one. Also, flowering stage is more sensitive stage to water deficit, while, capsule development stage is more tolerant stage in the growth stages of sesame.

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تأثير نقص مياه الرى على بعض أصناف السمسم فى مصر العليا

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أقيمت تجربتان حقليتان بشندويل (محافظة سوهاج) خلال موسمي ٢٠٠٥&٢٠٠٦ لدراسة تأثير تحريم الري على المحصول ومكوناته ومحصول الزيت وبعض العلاقات المائية لبعض أصناف السمسم.

وتهدف الدراسة إلى معرفة مدى تأثر الأصناف المختلفة للسمسم وكذلك حساسية الأطوار المختلفة داخل كل صنف لنقص المياه وتحديد أفضل الأصناف التي تعطى أعلى إنتاجية من حيث محصول البذور والزيت ومكونات الزيت وأعلى عائد من وحدة المياه المستعملة.

معاملات الدراسة:

المعاملات الرئيسية: معاملات الرى

١. I_1 :تحريم الري في طور النمو الخضري (بعد ٤٥ يوم من الزراعة).
٢. I_2 :تحريم الري في طور النمو الزهري (بعد ٦٠ يوم من الزراعة).
٣. I_3 :تحريم الري في طور تطوير الكبسولات (بعد ٩٠ يوم من الزراعة).
٤. I_4 :بدون تحريم (معاملة الكنترول ، الرى كل ١٥ يوم).

المعاملات الشقية: الاصناف

V_1(جيزة٣٢) & V_2 (توشكى١) & V_3 (شندويل٣) & V_4 (سوهاج١).

وقد أوضحت النتائج أن محصول البذور / ف ، وزن بذور النبات ، وزن ١٠٠٠ بذرة ، طول الكبسولة ، عدد كبسولات النبات ، محصول الزيت قد تأثرت معنويا بمعاملات الرى وقد سجلت معاملة الرى I_3أعلى القيم لجميع الصفات تحت الدراسة باستثناء طولة الكبسولة حيث تفوقت مع معاملة الرى I_4 .

ومن ناحية اخرى تفوق الصنف V_3 على الاصناف الاخرى فى محصول البذور / ف وقد بلغت نسبة الزيادة فى الموسم الأول ٣٤.٩ ، ٧.٩ ، ١٠.٣ % بالمقارنة مع الأصناف جيزة٣٢ ، توشكى١ ، سوهاج٣ على الترتيب. بينما بلغت الزيادة فى الموسم الثانى بنفس ترتيب الاصناف حوالى ٥٤.٣ ، ٥.٦ ، ٥.٩ %. وقد حقق التفاعل بين معاملة الرى I_3 مع الصنف V_3 أعلى محصول بذور.

وقد تفوق الصنف جيزة٣٢ فى نسبة حامض الاوليك (٤٤.٦٢ %) بينما تفوق الصنف سوهاج١ فى نسبة اوميجا٦ (٤٥.٩٠ %).

وقد أوضحت النتائج أيضا أن الاستهلاك المائى السنوى لمحصول السمسم فى الموسم الأول بلغ ٢٥٢٨ ، ٢٤٤٠ ، ٢٤٦٦ ، ٢٩٣٢ م٣ / ف لمعاملات الرى I_1 ، I_2 ، I_3 ، I_4 على الترتيب. بينما بلغ الاستهلاك المائى فى الموسم الثانى ٢٦٣٩ ، ٢٥٤٩ ، ٢٥٦٥ ، ٣٠٥٢ م٣ / ف لنفس ترتيب معاملات الرى.

هذا وتشير النتائج الى أن الاستهلاك المائى للاصناف فى الموسم الأول بلغ ٢٧٩٥ ، ٢٤٧٩ ، ٢٥٢٤ ، ٢٥٦٩ م٣ / ف للاصناف V_1 ، V_2 ، V_3 ، V_4 على الترتيب. وفى الموسم الثانى وبنفس ترتيب الاصناف بلغ الاستهلاك ٢٨٩٣ ، ٢٥٩١ ، ٢٦٣٧ ، ٢٦٨٤ م٣ / ف. وتوضح النتائج أن الصنف V_1 سجل أعلى استهلاك مائى للنبات بينما الصنف V_2 سجل أقل القيم يليه الصنف V_3. وقد حقق الصنف V_2 توفير فى مياه الرى فى الموسم الأول حوالى ١١.٣ ، ١.٩ ، ٣.٥ % وفى الموسم الثانى حوالى ١٠.٤ ، ١.٧ ، ٣.٥ % بالمقارنة بالاصناف V_1 ، V_3 ، V_4 على الترتيب. وقد أعطى التفاعل بين I_4 مع V_1 أعلى استهلاك مائى ، بينما التفاعل I_2 مع V_2 أعطى أقل استهلاك.

هذا وقد أوضحت النتائج أن العائد المحصولى من وحدة المياه قد تفوق مع معاملة الرى I_3 وكذلك مع الصنف V_3 وقد أعطى التفاعل بينهما أعلى عائد محصولى من وحدة المياه المستعملة. فى حين أن الصنف V_1 أعطى أقل عائد محصولى من وحدة المياه . وقد وجد أن التفاعل بين معاملة الرى I_4 وأى صنف من الاصناف تحت الدراسة قد أعطى عائد محصولى منخفض من وحدة المياه المستعملة فى حين أن التفاعل بين معاملة الرى I_3 وأى صنف قد حقق عائد محصولى مرتفع من وحدة المياه المستعملة.

مما تقدم يمكن استنتاج أن محصول السمسم من المحاصيل التى تحتاج الى تعطيش النباتات (أو اطالة الفترة بين الريات) فى بعض أطوار النمو الخاصة بها وهو طور تطور الكبسولات حيث أن نقص المياه فى هذه المرحلة يشجع النباتات على اعطاء المزيد من بذور النبات بالاضافة الى زيادة وزن البذور ومن ثم زيادة محصول الفدان. كما يمكن استنتاج أن الصنف شندويل٣ هو أكثر الاصناف تحملا للاجهاد المائى الناتج عن نقص المياه ، وأن طور التزهير هو أكثر الاطوار حساسية لنقص المياه بينما طور تطوير الكبسولات هو أكثرها تحملا. وبناءا عليه يمكن التوصية بزيادة المساحة المنزرعة من هذا الصنف فى محافظة سوهاج على حساب الاصناف الاخرى لزيادة انتاجية محصول السمسم وتقليل الفجوة بين الانتاج والاستهلاك علاوة على تحقيق أعلى استفادة من وحدة المياه المستعملة.

قام بتحكيم البحث

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