

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- I₁: Withholding irrigation at branching stage (45th day after sowing).
- 2- I₂: Withholding irrigation at flowering stage (60th day after sowing).
- 3- I₃: Withholding irrigation at capsule development stage (90th day after sowing).
- 4- I₄: Control (irrigation each 15 days).

Sub-plots: Sesame varieties:

- 1- V₁: Giza32 variety.
- 2- V₂: Toshky1 variety.
- 3- V₃: Shandaweel3 variety.
- 4- V₄: 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 %	Wilting 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/ cm²/ 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
 I₁ = withholding irrigation at the 45th days after sowing.
 I₂ = withholding irrigation at the 60th days after sowing.
 I₃ = withholding irrigation at the 90th days after sowing.
 I₄ = control (Irrigation each 15 days).
 V₁ = Giza32, V₂ = Toshky1, V₃ = Shandaweel3 and V₄ = 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 Soxhlet apparatus and hexane as solvent.

Determination of fatty acids:

Methylation of the triglycerides 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- μ m-film thickness. Column temperature 170°C and head pressure 3.5 psi. Carrier gas N₂, 30 ml and flow rate 2.0 ml/min. Injection port temperature 220°C and detector temperature 250°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/ m³ 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 I₃ treatment in both studied seasons except length of fruiting zoon (cm) which was increased for I₄ treatment. The application of I₃ treatment (withholding irrigation at the 90th day after sowing) increased sesame yield by 5.10, 24.10 and 44.30 % as compared with I₁, I₂ and I₄ 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)	
		2005	2006	2005	2006	2005	2006
Irr.	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 V₃ (Shandaweel3 CV.). The increase in seed yield for V₃ in 2005 reached about 34.90, 7.90 and 10.30 % as compared with V₁, V₂ and V₄, respectively. However, in 2006 the respective increase in seed yield using V₃ 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 I₃ with the variety V₃.

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 I₃ (withholding irrigation at the 90th 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 I₃ treatment reached about 2.8, 23.9 and 42.7 % as compared with I₁, I₂ and I₄ 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 I₃ with V₃.

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)	
		2005	2006	2005	2006	2005	2006
	Season						
Irr.	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 V _i 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.

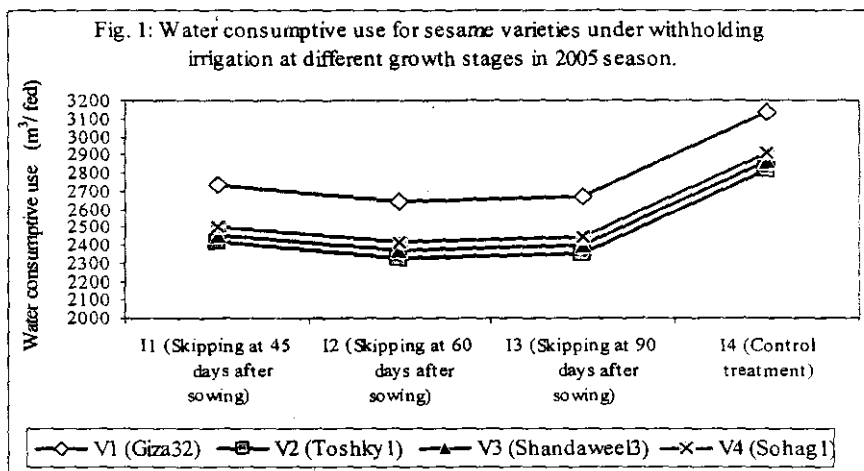
Component	Varieties			
	Giza32	Toshky1	Shandaweel3	Sohag1
Palmitic C16:0	9.11	9.06	8.72	9.73
Stearic C18:0	5.27	4.40	4.61	4.82
Arachidic C20:0	0.12	0.00	0.23	0.31
Oleic C18:1	44.62	41.30	41.15	38.78
Omega-6	40.34	44.86	45.21	45.90
Omega-3	0.34	0.31	0.27	0.48
TS*	14.50	13.46	13.56	14.86
TU**	85.31	86.47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

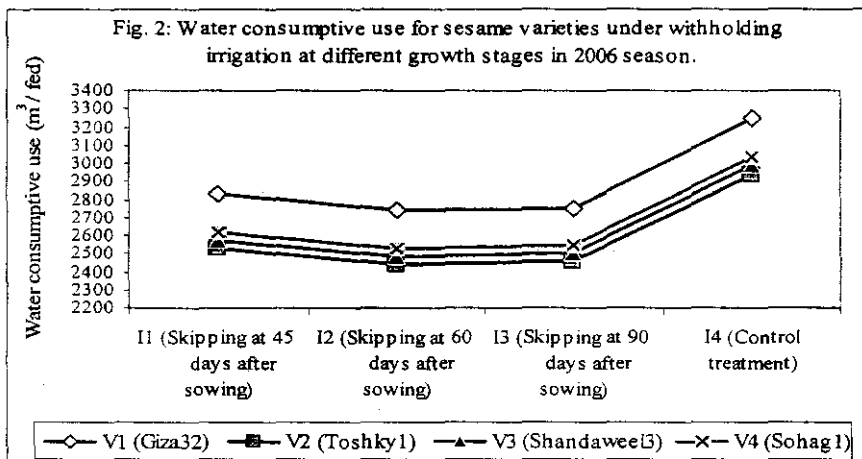
* TS=Total Saturated Fatty acids

** TU=Total Unsaturated Fatty acids

Water Consumptive Use

Seasonal water consumptive use or crop evapotranspiration (ET_{crop}) 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 ET_{crop} in 2005 were 2528, 2440, 2466 and 2932 m³/ fed for I₁, I₂, I₃ and I₄ treatments, respectively. The respective values in 2006 were 2639, 2549, 2565 and 3052 m³/ fed. Results indicated that few increases in ET_{crop} 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, I₄ treatment (without withholding irrigation) gave the maximum ET_{crop} in both seasons, while, I₂ treatment (withholding irrigation at 60 days after sowing, at flowering stage) registered the minimum value.





With respect to varieties, values of ET_{crop} in 2005 were 2795, 2479, 2524 and 2569 m³/ fed, for V₁, V₂, V₃ and V₄, respectively. However, in 2006, the respective values were 2893, 2591, 2637 and 2684 m³/ fed. Results indicate that V₁ variety registered the highest ET_{crop} in both seasons, however, V₂ gave the lowest one followed by V₃. Variety V₂ 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 V₁, V₃ and V₄, respectively.

The interaction between I₄ with V₁ gave the highest ET_{crop}, however, the lowest ET_{crop} was found for the interaction of I₂ with V₂ in both seasons.

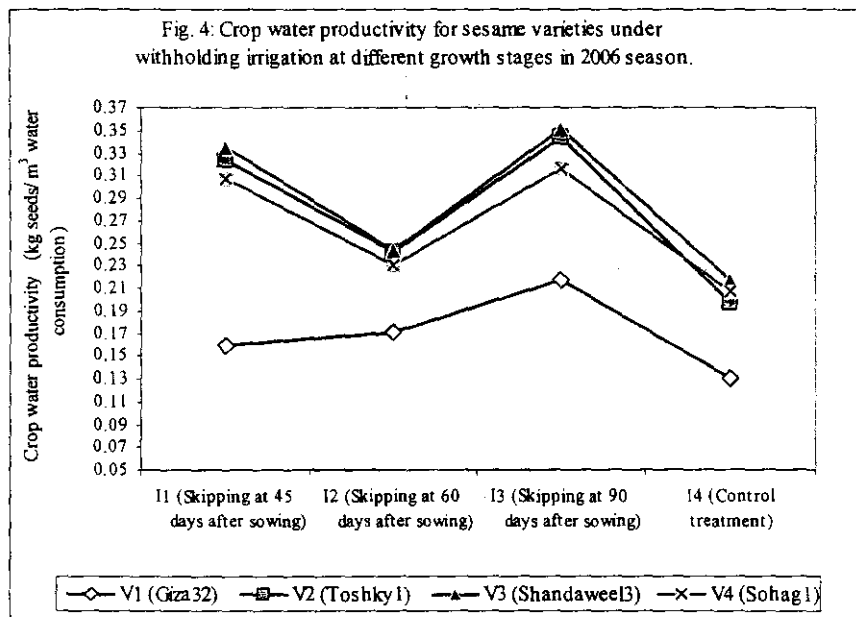
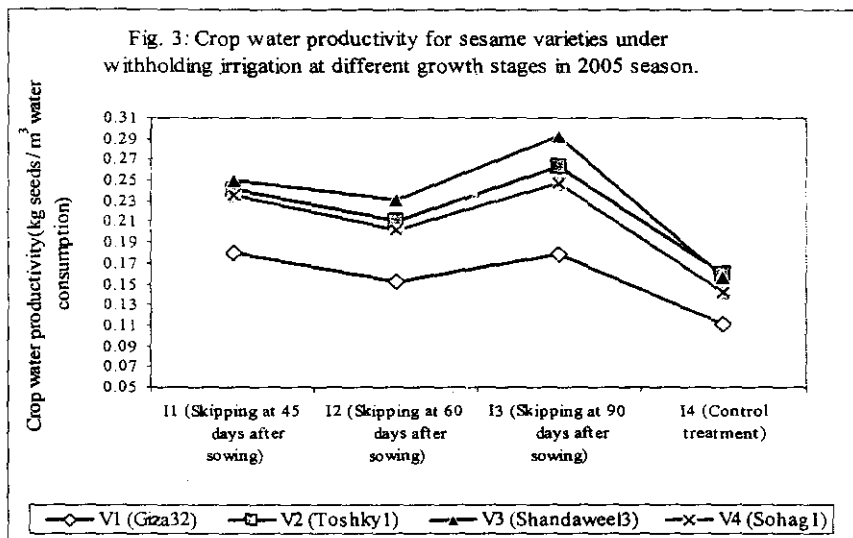
Crop Water Productivity (CWP)

Average values of CWP in 2005 were 0.23, 0.20, 0.25 and 0.14 kg seeds/ m³ water consumption for I₁, I₂, I₃ and I₄ treatments, respectively. Values in 2006 were 0.28, 0.22, 0.31 and 0.19 kg seeds/ m³ water consumption for the same respective irrigation treatments. Results clearly show that withholding irrigation at 90 days after sowing (I₃) 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 increases 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/ m³ water consumption for V₁, V₂, V₃ and V₄, respectively. However, the respective values in 2006 were 0.17, 0.28, .29 and 0.27 kg seeds/ m³ water consumption. It is clear that CWP increased for the variety V₃ followed by V₂ and V₄, while, the variety V₁ (Giza32) gave the lowest CWP in both studied seasons. This is expected as recorded V₁ 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 I₄ with V₁ gave the lowest CWP as compared with the other interactions. At the

same time, I₄ with any variety registered minimum values of CWP, while I₃ 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 I₃ with V₃.



From all previous results, it can be concluded that irrigation 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 (V₃) 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 الري على بعض أصناف السمسم في مصر العليا
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**المعمل المركزي للمناخ الزراعي - مركز البحوث الزراعية.

أقيمت تجربتان حقليتان بشندويل (محافظة سوهاج) خلال موسمي ٢٠٠٦ و٢٠٠٥ لدراسة تأثير
تحرير الري على المحصول ومكوناته ومحصول الزيت وبعض العلاقات المائية لبعض أصناف السمسم.
وتهدف الدراسة إلى معرفة مدى تأثير الأصناف المختلفة للسمسم وكذلك حساسية الأطوار المختلفة داخل كسل
صنف لنقص المياه وتحديد أفضل الأصناف التي تعطي أعلى إنتاجية من حيث محصول البذور والزيت
ومكونات الزيت وأعلى عائد من وحدة المياه المستعملة.

معاملات الدراسة:

المعاملات الرئيسية: معاملات الري

١. 1 : تحريم الري في طور النمو الخضري (بعد ٤٥ يوم من الزراعة).
٢. 2 : تحريم الري في طور النمو الزهري (بعد ٦٠ يوم من الزراعة).
٣. 3 : تحريم الري في طور تطوير الكبسولات (بعد ٩٠ يوم من الزراعة).
٤. 4 : بدون تحريم (معاملة الكنترول ، الري كل ١٥ يوم).

المعاملات الشقية: الأصناف

V₁ (جيزة ٣٢) & V₂ (توشكى ١) & V₃ (شندويل ٣) & V₄ (سوهاج ١).

وقد أوضحت النتائج أن محصول البذور / ف ، وزن بذور النبات ، وزن ١٠٠٠ بذرة ، طول الكبسولة ، عدد كبسولات النبات ، محصول الزيت قد تأثرت معنوياً بمعاملات الري وقد سجلت معاملة الري ١ أعلى القيم لجميع الصفات تحت الدراسة باستثناء طولة الكبسولة حيث تفوقت مع معاملة الري ١ .

ومن ناحية أخرى تفوق الصنف V₃ على الأصناف الأخرى في محصول البذور / ف وقد بلغت نسبة الزيادة في الموسم الأول ٣٤,٩ ، ٧,٩ ، ١٠,٣ % بالمقارنة مع الأصناف جيزة ٣٢ ، توشكى ١ ، سوهاج ٣ على الترتيب. بينما بلغت الزيادة في الموسم الثاني بنفس ترتيب الأصناف حوالي ٥٤,٣ ، ٥,٦ ، ٥,٩ % . وقد حقق التفاعل بين معاملة الري ١ و مع الصنف V₃ أعلى محصول بذور .

وقد تفوق الصنف جيزة ٣٢ في نسبة حامض الأوليك (٤٤,٦٢ %) بينما تفوق الصنف سوهاج ١ في نسبة اوميغا ٦ (٤٥,٩٠ %).

وقد أوضحت النتائج أيضاً أن الاستهلاك المائي السنوي لمحصول السمسم في الموسم الأول بلغ ٢٥٢٨ ، ٢٤٤٠ ، ٢٤٦٦ ، ٢٩٣٢ م^٣ / ف لمعاملات الري ١ ، ٢ ، ٣ ، ٤ ، على الترتيب. بينما بلغ الاستهلاك المائي في الموسم الثاني ٢٦٣٩ ، ٢٥٤٩ ، ٢٥٦٥ ، ٣٠٥٢ م^٣ / ف لنفس ترتيب معاملات الري.

هذا وتشير النتائج إلى أن الاستهلاك المائي للأصناف في الموسم الأول بلغ ٢٤٧٩ ، ٢٥٢٤ ، ٢٥٦٩ م^٣ / ف للأصناف V₁ ، V₂ ، V₃ ، V₄ على الترتيب. وفي الموسم الثاني وبفلس ترتيب الأصناف بلغ الاستهلاك ٢٨٩٣ ، ٢٥٩١ ، ٢٦٣٧ ، ٢٦٨٤ م^٣ / ف. وتوضح النتائج أن الصنف V₁ سجل أعلى استهلاك مائي للنبات بينما الصنف V₂ سجل أقل القيم يليه الصنف V₃. وقد حقق الصنف V₂ توفير في المياه الري في الموسم الأول حوالي ١١,٣ ، ١,٩ ، ٣,٥ % وفي الموسم الثاني حوالي ١٠,٤ ، ١,٧ ، ٣,٥ % بالمقارنة بالأصناف V₁ ، V₃ ، V₄ على الترتيب. وقد أعطى التفاعل بين ١ مع V₁ أعلى استهلاك مائي ، بينما التفاعل ٢ مع V₂ أعطى أقل استهلاك.

هذا وقد أوضحت النتائج أن العائد المحصولي من وحدة المياه قد تفوق مع معاملة الري ١ وكذلك مع الصنف V₃ وقد أعطى التفاعل بينهما أعلى عائد محصولي من وحدة المياه المستعملة. في حين أن الصنف V₁ أعطى أقل عائد محصولي من وحدة المياه . وقد وجد أن التفاعل بين معاملة الري ١ وأي صنف من الأصناف تحت الدراسة قد أعطى عائد محصولي منخفض من وحدة المياه المستعملة في حين أن التفاعل بين معاملة الري ١ وأي صنف قد حقق عائد محصولي مرتفع من وحدة المياه المستعملة.

مما تقدم يمكن استنتاج أن محصول السمسم من المحاصيل التي تحتاج إلى تعطيش النباتات (أو إطالة الفترة بين الريات) في بعض أطوار النمو الخاصة بها وهو طور تطور الكبسولات حيث أن نقص المياه في هذه المرحلة يشجع النباتات على إعطاء المزيد من بذور النبات بالإضافة إلى زيادة وزن البذور ومن ثم زيادة محصول القدان. كما يمكن استنتاج أن الصنف شندويل ٣ هو أكثر الأصناف تحملاً للإجهاد المائي الناتج عن نقص المياه ، وأن طور التزهير هو أكثر الأطوار حساسية لنقص المياه بينما طور تطوير الكبسولات هو أكثرها تحملاً. وبناءً عليه يمكن التوصية بزيادة المساحة المنزرعة من هذا الصنف في محافظة سوهاج على حساب الأصناف الأخرى لزيادة إنتاجية محصول السمسم وتقليل الفجوة بين الإنتاج والاستهلاك علاوة على تحقيق أعلى استفادة من وحدة المياه المستعملة.

قام بتحكيم البحث

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