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THE OPTIMAL USE OF LAND AND WATER AT TOSHKY FOR SESAME CROP PRODUCTION

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Abstract

The main goal of the government in the recent time is to realize integrated sustainable agriculture of Southern Valley regions. This forms continuous main support to overcome the environmental problems, decreasing population intensity in the Valley and Nile Delta and redistributes inhabitants to constitute new perfect settlements. The present work aims to study effective of different water amounts as well as nitrogen doses on sesame growth and yield under local climatic conditions. The experimental field is conducted in the farm of Agricultural Research Station at South Valley-Toshky, Agricultural Research Centre. The experiment involved treatments of four amounts of irrigation water (calculated water requirement is 2941 m^3/fd) distributed by sprinkler irrigation system daily as well as three doses of nitrogen fertilizers for sesame with four replicates in split plot design. The soil profile is shallow. The total calcium carbonate percentage changed from area to another; it varies from 10% to 16%. Therefore, it needs a good irrigation management to protect root system from damage. The soil salinity is low; pH ranged between 8.9 and 9.2. The soil fertility is different from part to another. Except iron and potassium, the soil fertility is low in most studied macro- and -micro nutrients. Moreover, the soil is low in organic matter, less than 0.5%, due to the dry conditions.

For sesame plant, results of yield indicate that except capsules number, the studied plant parameters responded to the application of irrigation water in this area. The results of the statistical analysis indicate that the plant height and weight of plant are significantly affected by application of water irrigation. The capsules number of sesame did not show any significant response to water application. Seeds weight and total yield are highly significantly affected with irrigation amount treatments. It could be recommended that using low nitrogen dose combined with less water application treatment gives a better seed yield in Toshky.

INTRODUCTION

Egypt is adopting an ambitious project for future development of large desertic lands in the extreme southern region of the country. Setting basic constructions is proceeding. This aims to solve many socio-economical problems and to create new settle-

ments, since the Nile Delta and Valley are over populated now. Agriculture is a basic and first activity in the procedure of development. Therefore, with a future view, the Ministry of Agriculture established the southern Valley Agricultural Research Station at Abo-Simble – Toshky in the year 1998 in an area of 60 feddans (1 feddan ≈ 4200 m^2) and expanded now to 100 feddans. The area is near Lake Nasser about 1300 Km from Cairo city and 280 Km south of Aswan city and about 40 Km north of the Sudan country. The climatic condition in the region is very hot in summer with a high evaporation rate and cold in night winter. The area was a virgin land, which had never been cultivated before; only natural and wild plants existed accidentally depending on soil moisture content available. In this region, agricultural practices are completely different from that in old lands of Delta and Valley. Early investigation in growing various crops in the area gave promising results (Abdel-Aal 1999, Abdel-Aal 2000, Abdel-Aal 2002 and Abdel-Aal 2003). Regarding soil characteristics in this area, many fragments and gravels are seen on soil surface of sandy loam texture. The soil profile is shallow 50 –100 cm deep. Stones are scattered through the whole profile to bedrock. Sprinkler irrigation system depends mainly on the water, taken from Lake Nasser, of very good quality; salinity is 140 ppm. Under the challenging high evapo-transpiration conditions, there is a need for more studies to develop a suitable technique of water management and a guideline for farmers and investors for the increase of the efficiency of irrigation per unit of crop production. The vital role of water, especially in dry desertic condition, implies that farming systems should benefit optimally from expected available water.

Sesame [*Sesamum indicum*] is an important oil crop in Egypt for food and industrial production. Many investigators have studied sesame quality such as Bayder *et al.* (1999), Days (2000) and Bakheit *et al.* (2001). They indicated that seeds yield varied between 900 and 1000 Kg/ha. For local stress environmental conditions, sesame is cultivated for the first time in the region under these stress environmental conditions. Although there is a lack of review in this respect there but are many work in old lands and sandy soils.

The present article is a pioneer research work done under such climatic conditions. This present research work aims to determine some soil conditions in the area and macro- and micro-nutrients present. Also, sesame growth and yield under varying amounts of water combined with different doses of nitrogen fertilizers are evaluated

under local climate condition.

MATERIALS AND METHODS

The sesame experiment is carried out during summer season of the years 2001 and 2002, at Southern Valley Agricultural Research Station (Toshky), Agricultural Research Centre. The Experimental farm is located in Abosimble city at latitude 22º 25 North and longitude 31º 50 East; and 182 m above sea level (a.s.l.). Meteorological data indicated that the maximum air temperature is 28 °C in winter (December – January) and 48 °C in summer (July – August). The average air temperature is 19 °C and 36 °C, while the average of soil temperature is 39 °C and 26 °C in summer and winter, respectively. The relative humidity is 17% in summer and 42% in winter.

A split plot design with four replications was followed. Main plots were devoted to water amount treatments and sub-plots to nitrogen level fertilizers. The experiment involved four treatments of water amount combined with three levels of nitrogen fertilizers (ammonium nitrate). The nitrogen was added in two doses; the first one was during soil preparation and the second dose was after 35 day from germination. In all treatments, two-tons chicken manure per feddan and 50 Kg P_2O_5/feddan natural rock phosphate (Rokaz) were spread while preparing the soil for cultivation, 24 K_2O/fed (potassium sulfate) were added three weeks after sowing. The area of the plot is 144 m^2 (12m X 12m). Sesame seeds were planted in rows. The water requirement (WR= 2941 m^3/fd) is calculated from meteorological data in situ using Penman Monolith methods (Smith, 1991 and Ainer *et al.* 1999) with 20 percent addition as leaching fraction; the total amount is 3647 m3 for total growing period. Salt content of Lake Nasser in water is 140 ppm. Sesame treatments are shown in Table 1.

Sesame (Giza 32) was cultivated in the same time (15 April 2001 and 2002) and harvested in 2, 10 August for I_4 and I_3 treatments, respectively, and 19 August for I_1 and I_2 treatments. The determined agronomic parameters of sesame plant were plant height (cm), capsules number/plant, weight of plant (g/m^2) and seeds weigh (g/m^2). Flowering time and total plant age were determined in days. Statistical analysis was performed according to Snedecor and Cochran (1981). Before cultivation, soil samples were taken and analyzed for chemical analysis, Table 2. Saturation percentage

(SP), electrical conductivity, soluble ions were determined (Page, 1982); pH was determined in 1:2.5 soil: water (Jackson, 1967). Available nitrogen was determined (Page, 1982), available potassium was determined using flame photometer and available phosphorous was determined using Olsen's method (Jackson 1967); zinc, iron, copper and manganese were determined according to Lindsay and Norvell (1978), Table 3.

Table 1. Irrigation and nitrogen fertilizers treatments for Sesame.

Symbol	Treatments
(I) Irrigation amounts	
I_1	Water Requirement + 20%
I_2	Water Requirement + 10%
I_3	Water Requirement (only)
I_4	Water Requirement – 20%
(II) Nitrogen Fertilizers (Ammonium nitrate)	
N_1	30 N unit/ feddan
N_2	45 N Unit/ feddan
N_3	60 N Unit/ feddan

RESULTS AND DISCUSSION

Soil Characteristics

Soil chemical analysis in soil saturation extract, including soil salinity and soluble anions and cations along with soil reaction (pH) are shown in Table 2. It is noticed that water saturation percentage (SP) ranges from 25 to 35. Soil pH varies between 8.5 and 9.2. Data of soil salinity in saturation extract is very low, EC values range from 0.6 to 1.2 dS/m. Results of anions and cations, in soil saturated paste, indicate that sulphate exceed chloride in most of profiles whereas bicarbonate is low. Bicarbonate varies between 0.97 and 1.70 meq/L; chloride ranges between 1.36 and 4.85 meq/L and sulphate varies between 2.11 and 5.9 meq/L. Regarding soluble cations, results generally indicate that sodium and calcium are dominant cations; sodium exceeds slightly calcium in most profiles. Cations follow the order of: sodium > calcium > magnesium > potassium. Sodium varies between 2.88 and 6.16 meq/L; calcium ranges from 2.06 and 4.64 meq/L and magnesium varies between 0.34 and 1.74meq/L. Potassium content is low.

Table 2. Soil chemical analyses.

Profile No.	Depth (cm)	PH 1:2.5	EC (dS/m)	SP	Anions (meq/L)				Cations (meq/L)			
					CO_3	HCO_3	Cl	SO_4	Ca	Mg	Na	K
1	0-25	8.9	1.15	28	-	1.46	4.85	5.90	4.64	0.76	6.16	0.65
	25-50	8.8	0.68	35	-	1.21	3.88	2.11	2.06	0.88	3.76	0.50
	50-70	8.9	0.80	30	-	1.21	3.88	3.99	3.09	0.34	5.00	0.65
2	0-25	8.7	1.20	25	-	1.46	4.85	5.45	4.64	1.74	5.00	0.38
	25-50	8.7	0.85	30	-	1.21	4.27	3.90	3.61	0.81	4.63	0.33
	50-70	8.8	0.65	30	-	1.21	2.91	2.93	3.09	0.83	2.88	0.25
3	0-25	8.7	0.75	28	-	0.97	4.85	3.46	3.06	0.88	4.88	0.46
	25-50	8.9	0.75	30	-	1.46	1.94	6.64	3.90	0.83	4.74	0.57
	50-70	8.7	0.60	32	-	1.70	1.36	5.55	3.90	1.32	3.09	0.30
4	0-25	8.7	0.70	30	-	1.46	1.94	4.87	3.09	0.83	3.75	0.60
	25-50	8.9	0.80	32	-	1.46	1.94	6.64	3.90	0.83	4.74	0.57
	50-70	8.7	0.60	32	-	1.70	1.36	5.55	3.90	1.32	3.09	0.30

Table 3. Available macro and micro elements in the studied soil samples.

Profile No.	Soil depth (cm)	Maco-micronutrients (mg/Kg soil)						
		Macro			Micro			
		N	P	K	Zn	Fe	Mn	Cu
1	0-25	15	8	125	1.55	1.80	2.45	0.43
	25-50	13	8	303	3.45	1.78	1.85	0.40
	50-70	15	10	307	1.07	1.02	1.78	0.35
2	0-25	38	6	69	1.36	1.98	1.89	0.39
	25-50	28	3	73	1.28	1.87	1.21	0.35
	50-70	17	4	55	1.17	1.36	1.53	0.35
3	0-25	36	12	315	1.58	1.52	1.44	0.29
	25-50	25	9	89	1.34	1.34	0.84	0.17
	50-70	34	10	96	0.98	1.21	1.34	0.24
4	0-25	39	7	209	1.20	1.23	2.17	0.28
	25-50	29	7	98	1.18	1.17	1.90	0.28
	50-70	36	6	91	1.55	1.57	1.52	0.28

With respect to soil fertility, the data are shown in Table 3. Nitrogen status in the soil ranges between low and moderate. Generally, available nitrogen values vary between 13 and 39 mg N / Kg soil. The lowest value is found in the deeper layers and the highest value is in the surface layers. Phosphorus status in the soil is low. The available phosphorus in the soil ranges between 3 and 12 mg P / Kg soil. The available potassium differs among soil profiles. In general, results indicated that potassium status in the soil is between moderate and high; values are between 55 and 315 mg K/Kg soil. For extractable micronutrients, zinc has almost similar values in the studied profiles, these values range between 0.98 to 1.58 mg Zn/Kg soil, except the second depth in the first profile. The values of iron in the studied profiles vary between 1.02 and 1.98 mg Fe/Kg soil. The values of manganese in the studied profiles range between 0.84 and 2.45 mg Mn/Kg soil. Data of copper are less than 1 mg/Kg soil, the values ranging between 0.17 and 0.43 mg Cu/ Kg soil.

Agronomic Component and Sesame Yield

Statistical analysis for some agronomic components and yield of sesame as affected by various irrigation water quantity and nitrogen fertilizers treatments in the seasons of summer 2001 and 2002 are shown in Table 4. The results indicate that, except plant heights as well as capsules number, the studied plant parameters responded to the amount of irrigation water applied in this area. The results of the statistical analysis indicate that weight of plant (g/m^2) is significantly affected, whereas seeds weight (g/m^2) and calculated total yield (Kg/fd) are highly significantly related to irrigation treatments.

Table 4. Analysis of variance for some sesame agronomic components as affected by amounts of irrigation and nitrogen fertilizers, (mean values for two seasons).

Treatments	Degree of Freedom	Plants Height	Capsules No/plant	Weight of plant	Seeds weight (g/m^2) or total yield (Kg/fd)
Irrigation (I)	3	(ns)	(ns)	*	* *
N-fertilizers (N)	2	(ns)	(ns)	(ns)	(ns)
I x N	6	(ns)	(ns)	(ns)	(ns)

*Significant at 5% ** Significant at 1% (ns) not significant

The data in Table 5 show that the plant ages till maturity in days varied depending on the amount of water application. The longest time was 126 days in treatments I_1 and I_2 and the shortest was 109 days in treatment I_4 (IR minus 20%). Similarly, the less amount of irrigation water treatment (I_4) realized early flowering after 37 (days). Whereas in higher amount of water treatment (I_1), the flowering was delayed up to 45 days. Therefore, in treatment I_4, 20% of water can be saved and time of maturity was decreased while a higher yield was obtained.

On the other side, concerning nitrogen fertilizers treatments, statistical analyses do not indicate any significant difference in all agronomic components either among the doses of nitrogen treatments or in their interaction with irrigation water amounts

Data of agronomic plant traits and sesame yield as affected with different water irrigation amounts and of nitrogen fertilizer dose treatments are shown in Table 5. Results indicate that the averages of plant height show no significant difference with amount of irrigation water but follow the order of: $I_1 > I_2 > I_3 > I_4$. Regarding nitrogen fertilizer treatments, the averages of plant height show no significant differences and varied between 83.3 and 92.9. With respect of plant weight (g/m^2), the values follow the order of: $I_1 > I_2 > I_4 > I_3$. For Capsules number, data show that the mean values are varying between 55 and 64.

For Seeds weight, data indicate that the averages followed the order of: $I_4 > I_1 > I_2 \approx I_3$. Statistical analyses show that seeds weight is highly significantly related to irrigation water amount treatments. Total sesame yield represented in Table 5 as Kg/fd and in Fig (1) as Ton/ha followed a similar manner.

The data in Figure 1 for total sesame yield (Ton/ha) show that the high yields are found in treatment I_4. Also, the highest yield in I_4 treatment is obtained with 45 unit N and is almost similar to that with 60 units N. A slight decrease of yield occurred with 30 unit N application. Therefore, the use of low level of nitrogen with less amount of water is effective to get high yield under Toshky condition.

As a general view, the highest yield was obtained under the lowest amounts of irrigation water used. This was accompanied with the shortest growing period of 109 days (instead of 126 days), and after a shorter flowering time of 37 days (instead of

45 days). It can be said that less water decreases the vegetative growth period and enhances early flowering and seeds formation; on the other hand, the loss of nutrients is generally lower under less amounts of water.

It may worth to mention that sesame plant is a very important food crop. It is cultivated for the first time in the virgin new land of Toshky. The results are optimistic to be extended in the region. However, more efforts and studies are needed.

Table 5. Average sesame agronomic components and yield as affected with amount of irrigation water and nitrogen fertilizer treatments at maturity, (mean values for two seasons).

Treatments		No of Days to harvest	Flowering time after germination (days)	Plant height (cm)	Capsules No/ plant	Weight of plants* (g/m^2)	Seeds weight (g/m^2)
Water Irrigation Amount	Nitrogen						
(I_1) IR plus 20%	30 Unit	126	45	91.7	70.0	253.0	66.7
	45 Unit			90.0	54.0	218.3	68.5
	60 Unit			95.0	52.0	226.7	69.5
	Mean			92.2	58.7	232.7	68.2
(I_2) IR plus 10%	30 Unit	126	45	88.7	65.0	200.0	57.8
	45 Unit			94.7	66.0	200.0	59.5
	60 Unit			89.0	62.0	221.7	68.3
	Mean			90.8	64.3	207.2	61.9
(I_3) IR (Only)	30 Unit	117	42	88.0	59.0	175.0	52.8
	45 Unit			83.0	53.0	178.3	69.5
	60 Unit			89.3	53.0	181.7	69.5
	Mean			86.8	55.0	178.3	63.9
(I_4) IR minus 20%	30 Unit	109	37	91.3	67.0	201.7	77.8
	45 Unit			85.3	66.0	191.7	85.3
	60 Unit			73.3	37.0	206.7	85.0
	Mean			83.3	56.7	200.0	82.7
L.S.D.	5%					28.2	3.3
LSD	1%					46.2	5.0

IR: Irrigation Requirement, fd: feddan ≈ 4200 m^2

* (Part of plants above ground surface).

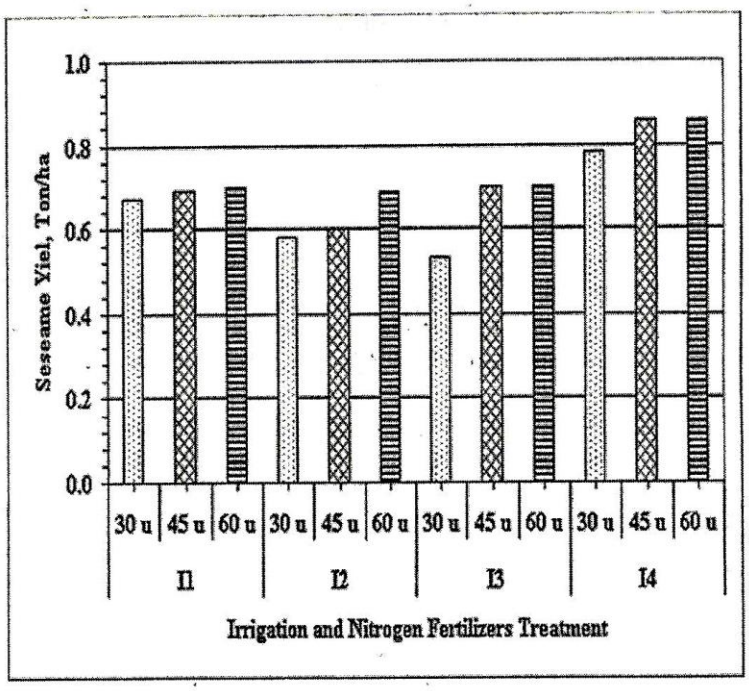

Fig. 1. Sesame yield (Ton/ha) as affected with Water irrigation amount and Nitrogen fertilizers treatments, (average values for replicates and two seasons).

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الإستخدام الأمثل للأراضى والمياه لإنتاج محصول السمسم فى توشكى

على إسماعيل نجيب عبدالعال

مدير محطة البحوث الزراعية بتوشكى - مركز البحوث الزراعية

أن أهم أهداف الدولة فى الوقت الحالى هو الإستدامة الزراعية المتكاملة لمنطقة جنوب الوادى وإستمرارية تكوينها هى الدعامة الأساسية لزيادة الدخل القومى وحل المشاكل البيئية من خلال زيادة وحدة المساحة بالنسبة للفرد، هذا بالإضافة لخفض كثافة السكان فى مناطق الوادى والدلتا القديمة وإعادة توزيعها فى مناطق عمرانية جديدة واعدة.

ويهدف العمل الحالى إلى دراسة مستويات مختلفة من كميات المياه مع مستويات مختلفة من التسميد الأزوتى على إنتاج محصول السمسم تحت الظروف المناخية الجديدة بالمنطقة. أقيمت تجربة حقلية بالموسم الصيفى خلال عامى ٢٠٠١ و ٢٠٠٢ بالمزرعة البحثية لمحطة البحوث الزراعية لجنوب الوادى- توشكى- التابعة لمركز البحوث الزراعية، وذلك بنظام القطع المنشقة لأربع معاملات مياه من الإحتياجات المائية المقدرة وهى: (١) الإحتياجات المائية الفعلية +٢٠٪ ، (٢) الإحتياجات المائية +١٠٪ ، (٣) الإحتياجات المائية الفعلية (٤) الإحتياجات المائية ناقص ٢٠ ٪ ، وكذلك ثلاث مستويات من التسميد الأزوتى (٣٠، ٤٥، ٦٠ وحدة أزوت/فدان) موزعة على المعاملات وذلك تحت نظام الرى بالرش الثابت، وقد قدرت الإحتياجات المائية ٢٩٤١م^3 للفدان تم إضافتها يوميا خلال مراحل عمر النبات.

أوضحت الدراسة أن هذه الأراضى بها بعض الصخور والأحجار المنتشرة على السطح بأحجام وأشكال وألوان مختلفة، ذات قطاع أرضى ضحل وتتراوح نسبة كربونات الكالسيوم الكلية من ١٠ إلى ١٦٪ مما يظهر ملامح وخواص الأراضى الجيرية التى يجب العناية بإدارتها لحماية جذور بادرات النباتات من التمزق والتلف بجفاف التربة، وملوحة التربة منخفضة ولو أن الأس الأيدروجينى مرتفع نسبيا، علاوة على ذلك فإن المادة العضوية وخصوبة التربة منخفضة بإستثناء كل من البوتاسيوم والحديد. وبالنسبة للنباتات ومحصول السمسم فإن النتائج توضح الإستجابة العالية مع نقص كميات المياه المضافة وعدم أستجابتها لمعدلات التسميد الأزوتى العالى، حيث أوضحت نتائج التحليل الإحصائى أن إستجابة أطوال النباتات وأوزان النباتات الكلى كانت معنوية مع معدلات المياه المستخدمة، وقد كانت أوزان الحبوب والمحصول الكلى مرتفع المعنوية مع معاملات كميات المياه، بينما عدد الكبسولات على النبات لم تظهر معنوية بهذه المعاملات التجريبية. ولهذا نوصى بعدم الإفراط فى إستخدام الأسمدة الأزوتية وزيادة كميات مياه الرى تحت ظروف توشكى لإنتاج محصول السمسم.