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

A. I. N. ABDEL-AAL

Director, Southern Valley Agricultural Research Station (Toshky)
Soils, Water & Envi. Res. Inst., Agric. Res. Centre, El-Gamaa St, Giza, Egypt

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Abstract

The new virgin area in the extreme part of southern Nile Valley of Egypt (Toshky) is very important to produce a clean agriculture free from pollution. In the southern valley, lands were not used for regular agriculture but they were left for natural cultivation whenever soil moisture was available. The climatic condition is dry and very hot in summer but cold in winter nights. The evaporation rate is very high in summer time; therefore, a suitable technique of water management is required to increase the efficiency of irrigation water used for crop production. Agriculture is the most important sector for creating and establishing a new settlement. The aim of this work is to study a suitable land and water resource management for crop production under local climatic condition. The study is conducted during summer 2001 and 2002 in the farm of South Valley Agricultural Research Station - Toshky, Agricultural Research Centre. The design of the experimental field involves water application treatments (I_1: WR+20%, I_2: WR+10%, I_3: WR only, I_4: WR –10% and I_5: WR – 20%. The water requirement (WR= 3674m^3/fd) is calculated from meteorological data in situ using Penman Monteith method. Salt content of Lake Nasser is 140 ppm. The water management is controlled daily by sprinkler irrigation system during different growing stages.

Soil profile is shallow (70 cm down to bedrock). The texture varies from sandy to loamy sand or sandy loam. Also, many fragments differing in shape, size and colour of various rocks and gravels are dominating on the soil surface and through the whole profiles. Total calcium carbonate varies from 10% to 16%. The soil is very low in organic matter. Soil salinity is low. The soil pH is about 9.0. As a result of soil physical and chemical properties as well as morphological features, the soil taxonomy could be classified as Typic xerofluvants, sand loam mixed, Hyper thermic. Concerning soybean plant, data of the statistical analysis indicate that the plants height, pods numbers, weight of plants and seeds weight are highly significantly related to irrigation water amount treatments. The highest yield was obtained with the highest amount of irrigation water.

INTRODUCTION

Different aspects of development in Egypt are undergoing for the solution of socio-economic problems under conditions of increasing population. Therefore, the integrated sustainable land use of Southern Valley regions forms continuous main support to overcome the environmental problems, to increase the occupied area with citizens, and to decrease population intensity in the Nile Delta and Valley. It is worthwhile to mention that this area will be an attractive region for southern Upper Egypt Governorates especially for Aswan, Quna and Sohag, to back up new settlements and to increase work chances for youth. Agriculture is the most important sector for creating and establishing new settlements. The new virgin area in the extreme part of southern Nile Valley of Egypt is very important to get clean agriculture free from pollution. In the southern valley, lands have never been cultivated before, only natural wild plants were exiting whenever soil moisture was available. The climatic condition is very hot in summer and cold in winter nights, low rainfall and dry. The evaporation rate is very high in summer time; therefore, a suitable technique of water management is required to increase the efficiency of irrigation water used for crop production. There is a need for more studies to develop appropriate guidelines for farmers and investors for sustainable agriculture and to prevent soil deterioration. The Lake Nasser south of Aswan high Dam and its long banks make the wide surrounded desertic lands able to carry out land reclamation projects in order to increase the soil potentiality for land use after seasonal flooding conditions and to cultivate it for about nine months using modern irrigation techniques. Because of the absence of available enough information and data, Ministry of Agriculture constructed a new Agricultural Research Station in Southern Valley at Abo-Simble (called Toshky). The Agricultural Station will deal with different branches especially those of soil, water and environmental fields, as well as field crops and horticulture.

Soybean that rich in protein and oil is a very important crop for food and industrial processes. Whigham *et al.* (1978) stated that environmental variables (altitude, longitude, day length, maximum and minimum temperatures) were found to be less important than management variables such as amount of applied fertilizers and nodulation as determinants of yield. Several investigators (Board and Hall, 1984, Sarmah *et al.* 1984, Boquet *et al.* 1985, Mohamed 1988, Ali 1993 and Shafshak *et al.* 1997) re-

ported that the management and sowing date play an important role in crop productivity. Under stress condition at Tosky, growing various crops give promising significant results (Abdel-Aal 1999, Abdel-Aal 2000, Abdel-Aal 2002 and Abdel-Aal 2003). The present wok is representing cultivation of soybean for the first time under this stress environmental condition. The present work is aiming to study suitable management of land and water resources to maximize crop production under local climate conditions.

MATERIALS AND METHODS

The study is conducted in the experimental field of the farm of Southern Valley Agricultural Research Station - Toshky, Agricultural Research Centre. It is at the extreme part of southern valley of Egypt about 1300 Km from Cairo and nearby Lake Naser and about 280 away from Aswan City. This area is about 40 Km north of border of the Sudan. Experimental farm is located in Abosimble city at latitude 22º 25 North and longitude 31º 50 East; and 182 m above sea level. The experiment is carried out during summer seasons of year 2001 and 2002 with soybean cultivation. The design involved five treatments of water amount. The treatments are: (i) water requirement (WR) + 20% (I_1), (ii) Water requirement (WR) + 10% (I_2), (iii) water requirement (WR) only (I_3), (iv) water requirement (WR) – 10% (I_4) and (v) (WR) water requirement – 20% (I_5). The water requirement (WR= 3674m^3/fd) is calculated from meteorological data in situ using Penman Monteith method (Smith, 1991 and Ainer *et al.* 1999) including 20 percent addition as leaching fraction. Salt content of Lake Nasser is 140 ppm. The water management is controlled daily by sprinkler irrigation system during different growing stages. Chicken manure before cultivation and recommended fertilizers for soybean were added. Experimental plots were fertilized with phosphorous at a rate of 30 kg P_2O_5/fed (super phosphate) during seedbed preparation and 24 kg K_2O/fed (potassium sulfate) three weeks after sowing. Seeds were inoculated with the specific rhizobia, and then hand-planted in soil. Nitrogen fertilizer was added as a starter dose two weeks after sowing at a rate of 20 kg N/fed (Ammonium sulfate). Hand weeding was practiced twice to control weeds during the first six weeks of the growing season. The design includes four replicates in a randomized complete block. The size of the plot is 18m^2 (3m X 6m). Soybean Giza 111 was cultivated in 1/5/2001 and harvested in 1/8/2001 in the first season and cultivated in 3/5/2002 and harvested in 3/8/2002 in

the second season. Most of plant traits and yield are determined. At harvest, the agronomic soybean plant parameters of plant height (cm), pods number/ plant, weight of plant (g/m^2) and seeds weight (g/m^2) and total yield (kg/feddan) were determined. Statistical analysis was carried out according to Snedecor and Cochran (1981). Soil samples were taken from four profiles and analyzed for soil particle size distribution, chemical analyses including electrical conductivity, pH and calcium carbonate. Permeability was determined using the international method reported by Page (1982). Morphological features (FAO-ISRIC, 1990) and soil classification are described according to Soil Survey Staff (1994).

RESULTS AND DISCUSSION

Main Meteorological Data and Soil Characteristics

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, respectively. 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.

The main morphological features of the studied area resulted from sandy rock soil that is affected to some extent by weathering process. The soil surface is covered with a thin alluvial layer. It is characterized by slightly undulation with presence of many fragments of various rocks and gravels. These fragments differ in their shape, size and colour. The proportion of coarse gravel differs from 5 to 15 percent. In general, the soil color ranges from yellow to yellowish brown and sometimes tendency to brownish-red. Most of soil particles are singular of loose consistency to friable. The particles get hard when dry and very soft when moist.

Soil taxonomy could be classified as Typic xerofluvants, sand loam mixed, Hyper thermic (according to Soil Survey Staff, 1994) as a result of soil physical and chemical properties as well as morphological features.

Table 1. Main soil chemical characteristics in soil suspension and saturation extract.

Profile No.	Depth (cm)	pH 1:2.5	EC (dS/m)	SP	Profile No.	Depth (cm)	pH 1:2.5	EC (dS/m)	SP
	0-25	8.9	1.15	28.0	3	0-25	8.7	0.75	28.0
1	25-50	8.8	0.68	35.0		25-50	8.9	0.75	30.0
	50-70	8.9	0.80	30.0		50-70	8.7	0.60	32.0
	0-25	8.7	1.20	25.0	4	0-25	8.7	0.70	30.0
2	25-50	8.7	0.85	30.0		25-50	8.9	0.80	32.0
	50-70	8.8	0.65	30.0		50-70	8.7	0.60	32.0

Table 2. Particle Size distribution, calcium carbonate and organic matter contents.

Profile No.	Depth (cm)	Organic Matter (%)	$CaCO_3$ %	Particle Size Distribution %				Soil water permeability (cm/hr)
				Sand		Silt	Clay	
				Coarse	Fine			
	0-25	0.50	12.00	43.90	41.20	5.70	9.20	10.57
1	25-50	0.10	10.00	52.40	29.20	7.20	11.20	10.06
	50-70	0.10	10.00	52.50	25.70	9.60	15.20	10.50
	0-25	0.40	16.00	82.60	11.80	3.40	2.20	15.20
2	25-50	0.10	12.00	79.90	12.30	4.60	3.20	15.00
	50-70	0.10	11.00	79.20	8.70	7.30	4.80	10.00
	0-25	0.50	11.50	73.00	30.00	29.70	3.30	9.56
3	25-50	0.40	9.00	31.50	20.00	39.00	9.50	9.06
	50-70	0.20	10.00	20.00	23.00	44.90	12.10	9.05
	0-25	0.50	10.00	50.50	21.80	18.00	9.70	9.00
4	25-50	0.30	12.00	45.70	22.80	17.00	14.50	9.00
	50-70	0.20	9.00	45.70	27.50	18.00	9.80	11.00

For soil salinity and reaction properties, data in Table 1 indicate that soil salinity is very low; it ranges from 0.6 to 1.2 dS/m. Soil reaction as represented with pH values ranges between 8.7 and 8.9. The soil saturation percent (SP) is low varying between 25 and 35 percent. Soil particles distribution varied from loamy to sandy loam texture along soil profile to bedrock (Table 2). The soil profile is shallow; the depth to the bedrock is 70 cm. The total calcium carbonate is found in considering amounts varies from 9 % and 16% (Table 2). The soil behaviour could be similar to that of calcareous soil

under both dry and wet conditions. Therefore, it needs a good irrigation management to protect the root system from damage. Organic matter is very low (Table 2), it ranges between 0.1% and 0.5%. Low organic matter is due to the natural weather of high temperature that increases the decomposition rate and also to shortage of vegetation. Relatively high values of organic matter may be due to added organic manures during cultivation. Data of soil permeability shown in Table 2 indicate that the permeability rate ranges from 9.0 to 15.2 cm/hr, which could be classified as very rapid.

Agronomic Component Characters and soybean yield

Data of analysis of variance for some agronomic components and yield of soybean as affected by various applications of irrigation water quantity treatments in the summer seasons 2001 and 2002 are shown in Table 3. The results indicate that all studied plant parameters responded to the indicated treatments. The results of the statistical analysis indicate that the plants height, pods number, weight of plants and seeds weight are highly significantly related to irrigation amount treatments. The studied season and the interaction between water irrigation amount and season do not show any significant differences.

Table 3. Analysis of variance for some soybean agronomic components as affected by irrigation water amount treatments of both studied seasons.

Treatments	Degree of Freedom	Plants height (cm)	Pods No/ Plant	Weight of plants (g/m^2)	Total yield (Kg/fd)
Irrigation (I)	4	* *	* *	* *	* *
Season	1	(ns)	(ns)	(ns)	(ns)
IR x Season	4	(ns)	(ns)	(ns)	(ns)

Data of agronomic components of soybean as affected by irrigation water amount treatments are shown in Table 4. Results indicate that the averages of plants height followed the order of: $I_5 > I_1 > I_4 > I_3 > I_2$ in the first season and $I_1 > I_4 > I_3 > I_5 > I_2$ in the second season . Pods number followed the order of: $I_4 > I_1 > I_5 > I_2 > I_3$ in both seasons. Regarding plants weight, the data expressed in g/m^2 followed the order of: $I_1 > I_2 > I_3 > I_4 > I_5$ in both seasons.

With respect to seeds weight expressed in g/m^2 as affected by irrigation water amount treatments, results indicate that the averages followed the order of: $I_1 > I_2 > I_3 > I_4 > I_5$ in both seasons. Data of yield Kg/feddan, shown in Table 4 and in Figure 1 in ton/hectare, for seasons 2001 and 2002 indicate that the highest total yield is obtained with treatment I_1 (water requirement plus 20% more); the lowest yield is obtained with treatment I_5 (water requirement minus 20%).

In general, results indicate that the plant height in treatment I_1, I_4 and I_5 are sometimes taller than with those of I_3 and I_2. Although enough number of pods are formed in the treatment I_4 but the seeds yield is low. This could be attributed to uncompleted maturity of seeds due to water deficiency.

Table 4. Agronomic components and soybean yield as affected by irrigation water treatments through the two studied seasons (means of four replicates).

Amount water treatments	Plant height (cm)		Pods No		Plant weight (g/m^2)		Seeds weight (g/m^2)	
	Seasons							
	2001	2002	2001	2002	2001	2002	2001	2002
I_1 (WR+20%)	48.8	51.3	38.3	40.0	735	795	273	306
I_2 (WR+10%)	36.5	39.5	31.8	32.8	597	642	222	236
I_3 (WR only)	43.8	43.5	30.8	31.8	505	523	180	185
I_4 (WR-10%)	46.3	46.0	44.3	41.8	458	452	172	175
I_5 (WR-20%)	49.8	40.3	34.8	35.5	409	423	150	163
LSD (5%) 2-T means	5.0		4.7		77.1		17.9	
LSD (1%) 2-T means	6.8		6.3		104.1		34.2	
LSD(5%) 2-T*Y means	3.5		3.3		54.5		11.3	
LSD(5%) 2-T*Y means	4.8		4.5		73.6		15.3	

It may be worth to mention that Toshky new virgin land has never been cultivated. This area is under stress environmental condition; the soil profile is shallow and the climate is extremely hot. However, optimistic results of soybean yield was obtained with irrigation water treatment of water requirement + 20% (I_1) for a cultivation period about three months in summer. On the other side, research work has to be oriented for the selection and breeding of varieties resistant to dry conditions.

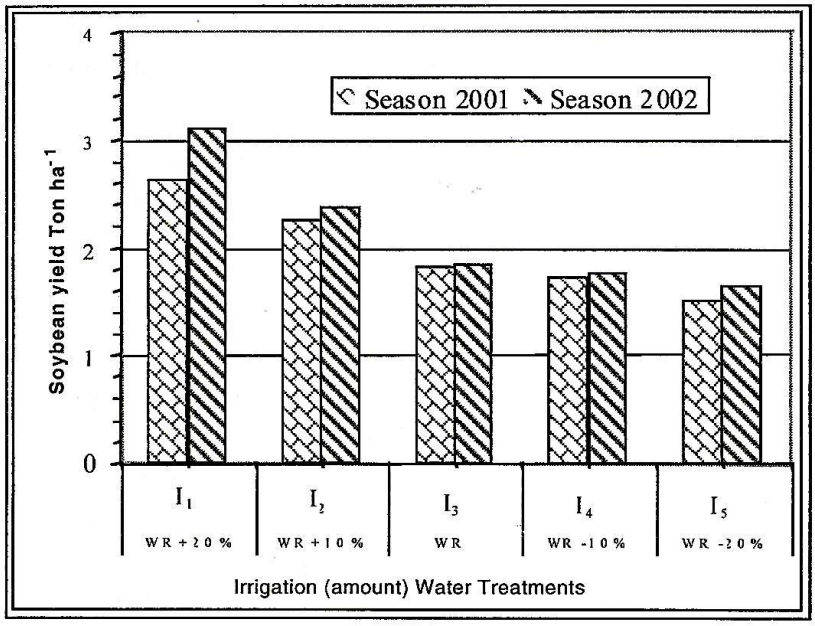

Fig. 1. Soybean yield expressed as Ton/ha as affected with irrigation (amount) water treatments for the two studied seasons.

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الإستخدام الأمثل للأراضى والمياه المضافة لإنتاج محصول فول الصويا فى توشكى

على إسماعيل نجيب عبدالعال

مدير محطة البحوث الزراعية بتوشكى - مركز البحوث الزراعية

ان الأراضى الجديدة التى تقع فى أقصى الجزء الجنوبى من وادى النيل بمصر (توشكى) تعتبر من الأهمية المرجوة للحصول على الزراعة النظيفة والخالية من التلوث، وهذه الأراضى لم تستغل فى الزراعة لقرون عديدة من الزمن ولكنها كانت تنتشر بها الزراعات الطبيعية من النباتات والأعشاب البرية وذلك حينما تتوافر الرطوبة المناسبة. وتتميزهذه البقعة من الأرض فى صفات بيئية قاسية سواء كانت مناخية أو أرضية مما يستتبعها إستخدام أسلوب مناسب لإدارة خدمةالأراضى والمياه والمحاصيل. وبما ان الزراعة هى عماد الدولة فى التنمية فإن الهدف الرئيسى من هذه الدراسة هو ملائمة الموارد الأرضية والمياه المتاحة لإنتاجية محصول فول الصويا مع الأخذ فى الإعتبار أنه أول بحث على فول الصويا أجرى فى هذه المنطقة تحت ظروف بيئية خاصة ومكمل لسلسلة من الدراسات لنفس المحصول ومحاصيل أخرى. وقد تمت الدراسة فى المزرعة البحثية لمحطة البحوث الزراعية بجنوب الوادى- توشكى- التابعة لمركز البحوث الزراعية خلال موسمى الصيف لعامى ٢٠٠١ و ٢٠٠٢، وقد صممت التجربة الحقلية بإحتوائها على خمسة معاملات للإحتياجات المائية والتى قدرت بمقدار ٣٦٤٧م^{3} (شاملة ٢٠ ٪ كإحتياجات غسيلية): (١) الإحتياجات المائية الفعلية +٢٠٪ ، (٢) الإحتياجات المائية+١٠٪ ، (٣) الإحتياجات المائية الفعلية فقط (٤) الإحتياجات المائية ناقص ١٠ ٪ ، الإحتياجات المائية ناقص٢٠٪، وقد أضيف ٢٠٪ إحتياجات غسيلية وقد تم توزيع هذه الكميات على المعاملات بنظام الرى بالرش خلال مراحل عمر النبات يوميا.

أوضحت الدراسات الظاهرية فى أرض التجربة بأن القطاع الأرضى سطحى يصل سمكه إلى ٧٠ سم فوق مادة الأصل، حيث يختلف قوام التربة من رملية إلى طمية رملية، هذا بالإضافة إلى وجود أشكال مختلفة من الأحجار ذات الأحجام المختلفة على السطح عبر القطاع وتتراوح كربونات الكالسيوم فى نسبتها من ١٠ إلى ١٦٪ والتربة منخفضة فى محتوها من المادة العضوية والملوحة وتميل هذه الأراضى للقلوية. ومن الدراسات الفيزيائية والكيماوية والخصائص المورفولوجية، أوضحت ان هذه الأراضى يتبع رتبة الأراضى ذات الوضع التقسيمى :

Typic xerofluvants, & Hyper thermic.

أما فيما يختص بنتائج التحليل الأحصائى لمحصول فول الصويا مع المعاملات المختلفة لكميات مياه الرى فكانت معنوية ومرتبطة بكل الخصائص المرتبطة بالمحصول بينما كانت عالية المعنوية لكل من عدد القرون لكل نبات، والوزن الكلى للنبات ووزن البذور للنبات والمحصول الكلى مع زيادة كميات المياه المستخدمة فى الرى للمعاملة الثانية والثالثة حيث زاد المحصول إلى المستوى الأمثل للإنتاج مع كمية مياه الرى + ٢٠٪، بينما انخفض المحصول بإنخفاض الكمية المضافة للرى

بناقص ٢٠٪ وناقص ١٠٪ عن الإحتياجات المائية الفعلية وحيث تعرضت النباتات للإجهاد الرطوبى المنخفض وعدم اكتمال نمو البذور فى الفترات الحرجة لعدم كفاية المياه بالرغم من زيادة عدد القرون فى المعاملات الاخيرة. ومن هنا يمكن تلخيص النتائج بالنسبة لمحصول فول الصويا بالنصيحة بإضافة كميات المياه المقدرة + ٢٠٪ ، وعدم تعرض النباتات لنقص كميات المياه للتأثير السلبى على إنتاجية المحصول تحت ظروف جنوب الوادى.