SEMI MECHANIZATION OF SUNFLOWER PRODUCTION IN NEW RECLAIMED CALCAREOUS SOILS IRRIGATED BY SALINETY WATER IN WEST NUBARIA AREA

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ABSTRACT

Most of drainage water is thrown to the Mediterranean Sea and northern lakes as waste water. To make use of this huge amount of drainage water, it needs a lot of experiments to be conducted in this task.

A field experiment was carried out at "Shabab El-Kharigin" in the region of Sugar Beat area as calcareous soil to study the effect of irrigation with drainage water and mixed drainage with canal (fresh) water on sunflower yield and soil properties under conventional tillage systems by using chisel plow and scraper, and moldboard plow followed by disc harrow and scraper. The tested variables were tillage systems (three levels), irrigation water quality (four levels), applied irrigation water (100 %, 80 % and 60 % from Evaporation pan or field capacity) and irrigation systems (trickle and furrow irrigation systems).

The results show that the sunflower crop was responded to be planted and growing under irrigated by salinity water and the yield did not affected in calcareous soil.

The obtained results revealed that the value of consumed power throughout the tillage operations were 51.18, 40.81 and 42.55 k.W at T_1, T_2 and T_3, and mean diameter of soil clods (W.M.D.) were 0.719, 0.721 and 0.734 cm at T_1, T_2 and T_3 after tillage operations.

Increasing applied water under furrow irrigation system from 1320 m^3/fed to 2200 m^3/fed increased the yield from 980 kg/fed to 1020 kg/fed and the same trend was observed with trickle irrigation system.

The trickle irrigation system gave the largest sunflower grain yield and consumed the least of irrigation water compared with furrow irrigation system.

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The soil salinity (ECe) increased with the increasing of salinity of irrigation water, and the observation indicated that the distribution of salts was different under the two irrigation systems; salts were pushed horizontally under the trickle irrigation system, meanwhile it was pushed vertically and horizontally under furrow irrigation system.

INTRODUCTION

Farmers at the tail end of irrigation canals suffer from shortage of water and they use drainage water to complete the water requirements for their crops. Most of drainage water (about 12.5 billion cubic meters) is thrown to the Mediterranean Sea and Northern Lakes (El-Wakeel and El-Mowelhi, 1993).

Newly reclaimed soils are characterized not only by less fertility than that in old soils but also by other physical and chemical properties causing serious problems due to salinity, high levels of calcium carbonates, wide irrigation intervals, …etc affected on yield production.

Increasing demands for irrigation water (while water resources are limited) will ultimately leads to reusing and recycling the available water resources. Field drainage, industrial and domestic waste waters are reused for irrigation in many parts of the world.

The increasing demand for irrigation water in the world, especially in the arid and semi arid regions, has forced farmers to use low quality water for irrigation, such as agricultural drainage water. Irrigation with high salinity drainage water during the whole growing season of the crops, especially the tolerant ones, does not produce high yield. Mixing agricultural drainage water as well as low quality ground water with good quality river water in ratios to control the salinity of the irrigation water below the threshold of the target crop was an acceptable practice and was used by many scientists (Pasternak et al., 1996; Suarez and Lebron, 1993; Oster, 1994)

Because water resources are limited and the cost of non-salinity water becomes prohibitive, crops of moderate to high salt tolerance can be irrigated with salinity water especially at later growth stages. The irrigation water can be a mixture of salinity with non-salinity water (blending). Salinity water can also be applied in cycles with non-salinity water. The use of salinity drainage water for irrigation has an environmental advantage. It reduces the non-salinity water requirement for salt tolerant crops and decreases the volume of drainage water requiring disposal or treatment.

Irrigation requires relatively large amounts of water. This water is a commodity that is becoming increasingly scarce. While relatively large quantities of water are required for irrigation, it can utilize water of a wide range of quality by appropriately selecting crops, irrigation methods and management practices.

Sunflower is considered one of the promising oil crops in Egypt, because its oil content ranged from 22-32% oil. So, Egypt may reduce the gab between oil production and the imported oil to meet the Egyptian consumption needs. The total production of sunflower seeds in Egypt was about 31,794,000 kg (Agricultural Economics Statistics (1999).

The optimum plowing conditions in sandy soil that give the favorite soil characteristics and highest yield were chisel plow 2 cross passes followed by rotary tiller or disc harrow for wheat and faba-bean (Metwalli, 1999)

The main objectives of this study were to focus on the importance of using drainage water for producing oil crops, solving the problems of irrigation canals at tail end and at the same time reduce the gab between production and consumption of oil under conventional tillage systems for this region.

MATERIALS AND METHODS

A field study was carried out at Sugar beat area "Shabab El-Kharigin" - West Nubaria region at the end of the irrigation canal and closed to the main drain to study the effect of irrigation using drainage water on sunflower yield and soil properties. Water storage was dug out with dimensions of 50 × 30 × 5 meters and covered with PE film of 0.7 mm thickness to mix water for irrigation. The used design was split split split plot design with three replicates. The main plots were assigned to water quality, the sub plots were assigned to irrigation systems, the sub sub plots were assigned to tillage systems and the sub sub sub plots were assigned to applied irrigation water treatments.

Treatments:-

1- Tillage systems as followed:

- Seven shares chisel plow 3 cross passes followed by scraper (T_1)

- Seven shares chisel plow 2 cross passes followed by scraper (T_2)
- Three bottoms moldboard plow one way followed by disc harrow and scraper (T_3)|.

2- Four irrigation water quality:

- Canal water (Q_1)
- Drainage water (Q_2)
- Mixed 1:1 canal to drainage water (Q_3), and
- Mixed 2:1 canal to drainage water (Q_4)

3-Three applied irrigation water (100 %, 80 % and 60 % from evaporation pan or field capacity).

4-Two irrigation systems

- Trickle, and
- Furrow irrigation systems.

Tillage implements:

Conventional tillage which suit for this area was 7 shares chisel plow 2 and 3 cross passes followed by scrapper, or three bottoms moldboard plow one way followed by disc harrow and scraper.

A locally seven-shares mounted chisel plow, two rows (3 share in first row and 4 shares in second row with 60 cm distance between rows and 60 cm clearance, and 25 cm between each two sequence shares) was used 2 or 3 cross passes as primary tillage (12 cm depth after first face; 20 cm depth after the second face and 25 cm depth after third face).The weight of plow is 800 kg.

A locally three bottoms moldboard plow width of bottom is 35 cm and working width is 105 cm and the clearance is 60 cm. The weight of plow is 950 kg. The depth of plowing is 25 cm.

A tandem heavy disc harrow working width is 240 cm, was used as secondary tillage after moldboard plow. The weight of disc harrow is 1100 kg.

A locally scrapper working width is ten feet (305 cm), was used as secondary tillage to harrowing and leveling soil. The weight is 650 kg.

Two common tractors namely "Belarus tractors" 90 hp (67.14 kW) were used, one to mounted chisel plow and trailed scraper and the other for helping to measure draft force (where this tractor is the common tractor in this area).

Weight mean diameter of soil clods (W.M.D.):

The following formula was used to calculate the W.M.D as Metwalli, 1999:

$$W.M.D. = (\sum(m \times w_i)) \; w_t$$

Where: W.M.D. = mass mean diameter, mm,

w_t = mass of soil sample, kg.

w_i = mass of remained over sieve, kg.

$m = (m_{(i-1)} + m_i)/ 2$ = mean mesh size of sieve, mm.

The tested variables were:

- Irrigation Methods:
  1. Trickle irrigation with spacing 50 cm between drippers and 60 cm between drip lines, drippers were GR type 4 liters/h and PE pipe were 16 mm outer diameter.
  2. Furrow irrigation with spacing of 60 cm between furrows.
- Water quality for irrigation:
  3. Canal (fresh) water. Q_1
  4. Drainage water. Q_2
  5. Mixed 1:1 canal (fresh) to drainage water Q_3.
  6. Mixed 2:1 canal (fresh) to drainage water Q_4.
- Applied water quantity;
  7. 100 % E pan
  8. 80 % E pan
  9. 60 % E pan.

Measurements:

- Tractor forward speed through operations by using stopwatch and measure tap.
- Draft force by using hydraulic dynamometer and helping tractor.
- Plowing depth.
- Electrical conductivity of water used at each case of irrigation (for the four water quality treatments).
- Electrical conductivity before and after the growing season for each case of water treatment.
- Sunflower yield.

- Applied water for the whole season.
- The required power calculated from the following formula:

$$P_p = \frac{P.S}{1000}$$, (Mohamed et al, 1995)

Where: P_p = power requirement of pull, kW.
P = net pull force, N. S = forward speed of plowing, m/s.

- Water utilization efficiency, was calculated by the following formula:

$$\text{WUtE} = \frac{\text{Seed yield in kg/fed}}{\text{Applied water in cubic meters / fed.}}$$

Where:
WUtE = Water Utilization Efficiency in kg seeds/m^3 water applied.

- ETo

Reference crop evapotranspiration ETo was computed by Penman Monteth according to Smith (1991) as follows:

$$ETo = \frac{0.408\Delta(Rn - G) + \gamma \frac{37}{Thr + 273} u2\,(e^\circ\,(\text{Thr}) - \text{e}a)}{\Delta + \gamma(1 + 0.34\text{u2})}$$

$$ETc = \text{ETo} * \text{Kc}$$

Where: - ETc = Evapotranspiration of crop,
- Kc = Crop coefficient,
- ETo = Reference evapotranspiration (mm houre^{-1}),
- Rn = net radiation at the grass surface, (MJm-2hour^{-1})
- G = soil heat flux density (MJm-2hour^{-1}),
- Thr = mean hourly air temperature (°C),
- Δ = Saturation slope vapor pressure curve at Thr (Kpa°C^{-1}),
- γ = psychometric constant ((Kpa°C^{-1}),
- eo (Thr) = saturation vapor pressure at air temperature Thr ,
- ea = average hourly actual vapor pressure,
- u2 = average hourly actual wind speed (ms^{-1}).

Data were analyzed by COSTAT software according to CoHairt (1986). Tables (1-a and 1-b) presented the soil analysis before starting the study.

Table 1-a: Soil properties of experimental site before starting study.

Soil sample depth, cm	Sand, %	silt, %	Clay, %	Texture class
0 - 30	58.9	24.2	16.9	Sandy loam
30 - 60	52.5	30.8	16.7	Sandy loam

Soil sample depth cm	ECe DS/m	pH	Bulk density g/cm^3	Field Capacity %	Welting point %
0-30	0.6	8.2	1.32	22.1	12
30-60	0.8	8.3	1.50	20.0	11

Table 1-b: The chemical analysis of experimental site before starting study.

Depth of sample, cm	0 - 15	15 - 30	30 - 45
CaCo^3 %	34.35	28.95	29.25
S.P. %	148.0	44.3	93.3
PH	7.59	7.41	7.47
E.C., ds/m	7.9	7.41	7.47
Na^+, meg/L	48.8	56.0	46.8
K^+, meg/L	0.49	0.92	1.16
Ca^{++}, meg/L	26.0	17.2	14.9
Mg^+, meg/L	19.9	12.2	10.5
Co_3^-, meg/L	0	0	0
H Co_3^-, meg/L	3.0	3.0	2.2
Cl^-, meg/L	22.0	29.0	26.0
SO_4^-, meg/L	25.8	8.83	10.7
N, P.P.M.	1196	1378	818
P, P.P.M.	43.0	7.9	5.2
K, P.P.M.	6.8	67.0	54.0
Fe, P.P.M.	5.1	3.7	7.1
Mn, P.P.M.	2.9	2.3	2.0
Zn, P.P.M.	0.60	0.28	0.86
Cu, P.P.M.	0.92	0.70	0.62

Table 2 shows the average electrical conductivity of canal and drainage water used in this study.

Table 2: The average EC of water applied to the four water quality treatments in dS^{-1}.

Treatment	Average EC for applied water along the growing season.
WQ_1	0.99
WQ_2	3.68
WQ_3	2.45
WQ_4	1.65

RESULTS AND DISCUSSIONS

- Power requirement for tillage operations:

T_1 = three cross faces chisel plow followed by scraper.

T_2 = two cross faces chisel plow followed by scraper.

T_3 = moldboard plow followed by disc harrow and scraper.

The results of measured tractor forward speed, draft force and calculated power throughout tillage operation were presented in table (3). It can revealed that systems total net consumed power to prepare soil for plant seeds were 51.18, 40.81 and 42.55 kW at T_1 , T_2 and T_3 respectively. System T_2 consumed the least of power then system T_3 but system T_1 consumed the largest power. Also, the moldboard plow consumed the largest power compared with chisel plow one face. The obtaining pulverization (W.M.D.) was 0.719, 0.721 and 0.734 cm at T_1, T_2 and T_3 respectively after tillage operations.

Table 3: Power requirement for different tillage operations:

Tillage Operation	**Forward speed Km/h**	**Draft kN**	**Power Kw**	**Depth of plowing cm**
Chisel 1st face	**4.72**	**10.3**	**13.5**	**12**
Chisel 2nd face	**4.39**	**9.78**	**11.93**	**20**
Chisel 3ed face	**4.00**	**9.34**	**10.37**	**25**
Moldboard plow	**4.14**	**12.15**	**13.97**	**25**
Disc harrow	**5.83**	**8.15**	**13.20**	**10**
Scraper	**6.55**	**8.45**	**15.38**	**--**

a) Sunflower grain yield:

Table A1 (appendix 1) shows the sunflower seed yield as affected by water quality, irrigation systems, tillage systems and applied irrigation water and table (4) shows the data analysis.

The analysis of yield data shows that the yield not effected with tillage systems (T_1, T_2 and T_3), where the yield is non-significant affect with tillage systems, but, it effected by applied water, irrigation systems and water quantity.

Also, the interaction between tillage systems with irrigation systems, and applied water with tillage systems is non-significant, and the interaction between applied water with irrigation systems was significant.

Sunflower seed yield was affected with water salinity quality and the applied water added with the two irrigation system.

Table (4): The results of data analysis for sunflower yield:

treatment	L.S.D.$_{0.0}$		Interaction
Applied water	0.0169		
80 %	1.0642	a	Applied water × tillage sys. = no. S
100 %	0.99791	b	Applied water.× Irrigation sys.= S
60 %	0.89958	c	Applied water.× water quality = S
Tillage systems	0.0439		
T3	1.00041	a	Tillage sys.× irrigation sys. = no. S
T2	0.98203	a	Tillage sys.× water quality = no. S
T1	0.97916	a	
Irrigation systems	0.04399		
Surface	1.0544	a	Irrigation water × water quality = S
Furrow	0.9200	b	
Water quality	0.062225		
Canal	1.1172	a	
Drainage	1.0550	a	
1 : 2 canal : drainage	0.9666	b	
1 : 1 canal : drainage	0.8100	c	

b) Applied Water:

Table 5 shows the applied water for sunflower under the two irrigation systems and the three irrigation treatments.

Table 5: Applied irrigation water m^3 /fed for the whole season of sunflower.

Treatments	Applied water, m^3 / fed		
	100 % E pan	80 % E pan	60% E pan
Furrow Irrigation System	2200	1760	1320
Trickle Irrigation System	1250	1000	750

Table 5 showed that the data of water salinity had affected the sunflower seed yield with the two irrigation systems (furrow and trickle). Increasing applied water under furrow irrigation from 1320 m^3/fed up to 2200 m^3/fed has increased the yield from 980 kg/fed. up to 1020 kg/fed under furrow irrigation system and the same trend was observed with trickle irrigation system.

The relationship between applied water and sunflower grain yield was represented in fig. (1) at the two irrigation systems. From figure can be observed that the trickle irrigation system gave the largest yield at the all levels of applied water (60, 80 and 100 % of E pan) compared with furrow irrigation system. Also, the best sunflower grain yield was at applied water 80 % of E pan at the tow irrigation systems (trickle and furrow).

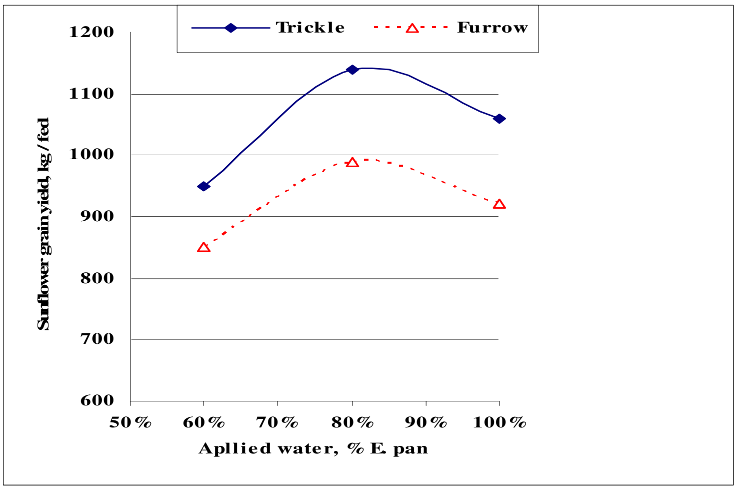

Fig. 1: The relationship between applied water and sunflower grain yield at the two system of irrigation.

c) Water Utilization Efficiency (WUtE)

Table 6 presents the WUtE in kg/m^3 applied water for sunflower as affected by irrigation systems used and water quantity of applied irrigation water.

Table 6: WUtE in kg sunflower grain yield/m^3 applied water.

		WUtE, k / m^3		
Treatments		100 % E pan	80 % E pan	60% E pan
Furrow irrigation system	Q_1	0.464	0.642	0.742
	Q_2	0.327	0.153	0.530
	Q_3	0.377	0.500	0.561
	Q_4	0.405	0.523	0.629
Trickle irrigation system	Q_1	0.96	1.32	1.347
	Q_2	0.712	0.9	1.173
	Q_3	0.816	1.07	1.24
	Q_4	0.88	1.12	1.373

Table 6 presents WUtE values. It shows that trickle irrigation system is the best for sunflower in case of using mixed saline water and with less applied water. The WUtE under trickle irrigation system ranged from 0.712 to 1.373 kg/m^3 applied water, where under furrow irrigation system it did not reach these values (it ranged from 0.153 to 0.742 kg/m^3 under furrow irrigation system).

d) Electrical conductivity of soil

Figures 2 and 3 show the electrical conductivity of soil paste extraction for (0-30cm depth of the soil, for both trickle and furrow irrigation systems.

From the two figures, it can be seen that the applied water quantity has highly effected on soil salinity in the surface layer 0-30 cm, and increasing the quantity of applied water decreased the electrical conductivity of the soil. That is due to leaching of salts down the root-zone area. Also, the water quality (water salinity) affects soil electrical conductivity. The highest soil electrical conductivity was obtained from WQ2 (drainage water).

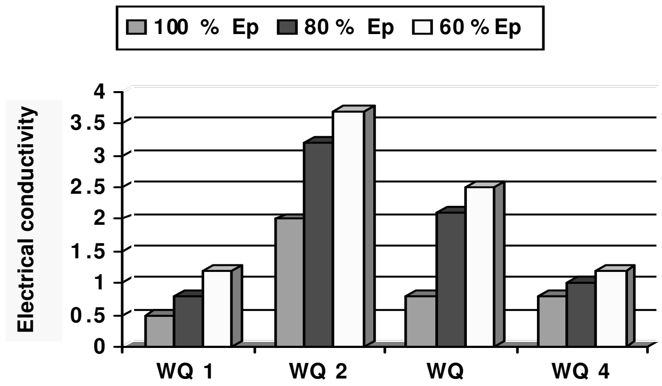

Fig. 2: Electrical conductivity (dSm^{-1}) of the soil under furrow irrigation system

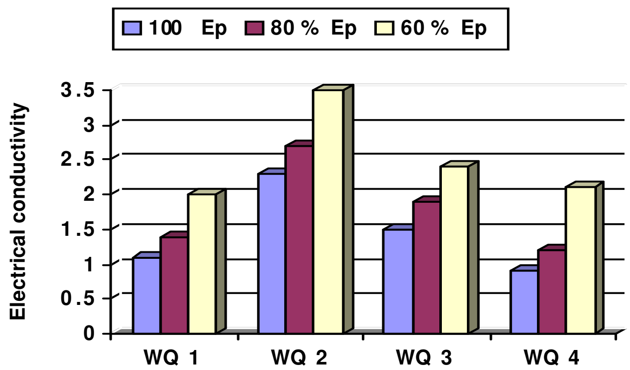

Fig. 3: Electrical conductivity (dSm^{-1}) of the soil under trickle irrigation system.

Effect of salinity water on yield:

Fig. 4 shows the relationship between water quality (salinity water) and sunflower grain yield. The quality of water affected on sunflower grain yield.

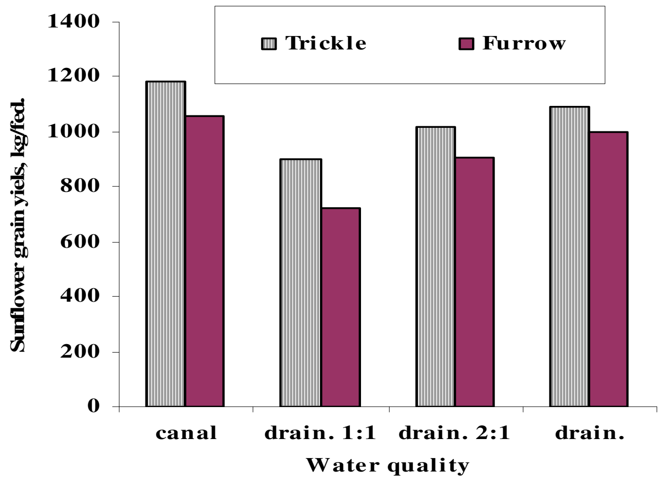

Fig. 4: Effect of salinity water on sunflower yield at the two systems of irrigation (drain = drainage water).

The canal water gave the highest yield than the mixed between canal and drainage water at the tow systems of irrigation (trickle and furrow).

SUMMARY AND CONCLUSION

A field Study was carried out at "Shabab El-Kharigin" in the region of Sugar beat area at the end of the irrigation canal and closed to the main drain to study the effect of drainage water on sunflower yield and soil properties. The treatments of that work were:

1- Tillage systems as followed (three levels)

2- Four irrigation water quality (four levels - Canal water, drainage water, mixed 1:1 canal to drainage water, and mixed 2:1canal to drainage water)

3-Three applied irrigation water (100 %, 80 % and 60 % from Evaporation pan).

4-Two irrigation systems (trickle and furrow irrigation systems).

The results show that the sunflower crop was responded to be planted and growing under irrigated by salinity water and the yield did not effected in calcareous soil at Sugar Beet area.

The values of total net power consumed to prepare soil are 51.18, 40.81 and 42.55 kW at T_1 (three cross faces chisel plow followed by scraper), T_2 (two cross faces chisel plow followed by scraper) and T_3 (moldboard plow followed by disc harrow and scraper) respectively, the soil pulverization (W.M.D.) is 0.719, 0.721 and 0.734 cm at T_1, T_2 and T_3 after tillage operations.

The yield was not affected by tillage systems (T_1, T_2 and T_3), where the yield is non-significant affect with tillage systems at the level of test at 0.05.

Increasing applied water under furrow irrigation system from 1320 m^3 to 2200 m^3/fed has increased the yield from 980 kg/fed to 1020 kg/fed under furrow irrigation system and the same trend was observed with trickle irrigation system.

The trickle irrigation system gave the highest sunflower grain yield and consumed the least of irrigation water compared with furrow irrigation system.

Recommendation

The sunflower crop is recommended to be planted with salinity water (by 2 : 1mixed between canal "fresh" and drainage water respectively) and trickle irrigation system in calcareous soil at Sugar Beet area – Nubaria region. Also, preparing soil by two cross passes 7 shares chisel plow followed by scraper. Where that is gave the highest sunflower grain yield and consumed the least of irrigation water and power requirement.

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الملخص العربى

الميكنة الجزئية لأنتاج محصول عباد الشمس بالأراضى الجيرية المستصلحة حديثاً تحت الرى بمياه عالية الملوحة بمنطقة بنجر السكر بغرب النوبارية

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تتم حركة غالبية مياه الصرف إلى البحر الأبيض المتوسط أو إلى البحيرات الشمالية. إعادة أستخدام هذه المياه تحتاج إلى العديد من الدراسات. أجريت تجربة بمنطقة بنجر السكر غرب ترعة النوبارية بأراضى شباب الخريجين ذات الأراضى الجيرية بمنطقة بنجر السكر وذلك

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لدراسة تأثير الرى بمياه المصرف وبمياه مخلوطة من المصرف وترعة الرى على محصول عباد الشمس وكفاءة أستخدام المياه وملوحة التربة تحت ظروف إعداد مرقد البذرة التقليدية بأستخدام نظم الحرث التقليدية المتبعة بالمنطقة وهى: النظام الأول T_1 المحراث الحفار 7 سلاح 3 أوجهه متعامدة متبوع بالقصابية لتكسير القلاقيل وتنعيم وتسوية التربة، والنظام الثانى T_2 المحراث الحفار 7 سلاح وجهين متعامدين متبوع بالقصابية لتكسير القلاقيل وتنعيم وتسوية التربة، والنظام الثالث T_3 محراث قلاب ثلاثة أبدان متبوع بالمشط القرصى الثقيل ثم القصابية. وتم أستخدام أربعة أنواع من مياه الرى هى: 1- مياه ترعة 2 - مياه مصرف 3 - مياه مخلوطة 1:1 ترعة الى مصرف

4 - مياه مخلوطة 2:1 ترعة الى مصرف، و تم أستخدام نظامين للرى ، هما الرى بالخطوط والرى بالتنقيط.

وقد أوضحت النتائج أستجابة محصول عباد الشمس للزراعة والنمو فى الراضى الجيرية بأراضى بنجر السكر بمنطقة غرب النوبارية، وأن درجة تحبب التربة كانت 0.719 ، 0.721 و 0.734 سم عند نظم الحرث T_1 ، T_2 و T_3 وأن القدرة المستهلكة فى تجهيز التربة للزراعة كانت كما بالجدول التالى:

عمليات تجهيز التربة للزراعة	السرعة الأمامية كم / س	قوة الشد ك. نيوتن	القدرة ك. وات	عمق الحرث سم
حرث بالحفار وجهه أول	**4.72**	**10.3**	**13.5**	**12**
~ ~ ~ **ثانى**	**4.39**	**9.78**	**11.93**	**20**
~ ~ ~ **ثالث**	**4.00**	**9.34**	**10.37**	**25**
حرث بالقلاب 3 بدن	**4.14**	**12.15**	**13.97**	**25**
تكسير بالمشط القرصى	**5.83**	**8.15**	**13.20**	**10**
تنعيم وتسوية بالقصابية	**6.55**	**8.45**	**15.38**	**--**

كذلك فإن محصول الحبوب لم يتأثر بتغيير نظم الحرث بينما تأثر محصول الحبوب بنظام الرى و بملوحة ماء الرى حيث تناقص محصول الحبوب بزيادة الملوحة.

كما أظهرت النتائج أن كمية المياه المضافة تراوحت بين (1300 الى 2200) م3/فدان للموسم للرى بالخطوط. بينما كانت بين (750 الى 1250) م3/فدان للرى بالتنقيط. وكذلك أن الملوحة للتربة تقل بزيادة المياه المضافة وأن الملوحة تزداد بزيادة ملوحة المياه المضافة.

كما أوضحت النتائج أن نظام الرى بالتنقيط أعطى أعلى محصول عند كل مستويات الماء المضاف كنسبة من ناتج حلة البخر (60، 80 و 100 ٪ من E pan) مقارنة بنظام الرى بالخطوط السطحية، كما أن نسبة الماء المضاف (80 ٪ من E pan) أعطت أعلى أنتاجية مقارنة بنسب الأضافة الأخرى. أى أن نظام الرى بالتنقيط أعطى أعلى أنتاجية وأستهلك كمية مياة أقل مقارنة بنظام الرى بالخطوط السطحية.

Appendix

Table A1: The seed yield of sunflower kg/fed, as affected by tested variables.

Water quality	Irrigation Systems	Tillage systems	Applied Irrig. water	Sunflower Yield (× 1000 kg\fed)			
				R1	R2	R3	mean
Q1 Canal water	Trickle	T1	100 %	1.23	1.15	1.22	1.20
			80 %	1.33	1.29	1.34	1.32
			60 %	1.00	1.04	0.99	1.01
		T2	100 %	1.19	1.16	1.25	1.20
			80 %	1.29	1.37	1.33	1.33
			60 %	0.97	1.01	1.02	1.00
		T3	100 %	1.22	1.20	1.24	1.22
			80 %	1.28	1.34	1.37	1.33
			60 %	0.98	1.01	1.04	1.01
	Furrow	T1	100 %	1.04	1.02	1.06	1.03
			80 %	1.15	1.17	1.16	1.16
			60 %	0.98	0.99	0.94	0.97
		T2	100 %	1.01	0.99	1.03	1.01
			80 %	1.13	1.11	1.18	1.14
			60 %	1.00	0.98	0.99	0.99
		T3	100 %	1.05	1.00	0.98	1.01
			80 %	1.15	1.13	1.17	1.15
			60 %	1.03	1.03	1.00	1.02
Q2 1 : 1 Canal : drainage	Trickle	T1	100 %	0.87	0.90	0.90	0.89
			80 %	0.92	0.94	0.87	0.91
			60 %	0.84	0.89	0.91	0.88
		T2	100 %	0.89	0.94	0.90	0.91
			80 %	0.93	0.89	0.94	0.92
			60 %	0.86	0.89	0.89	0.88
		T3	100 %	0.91	0.89	0.90	0.90
			80 %	0.93	0.91	0.92	0.92
			60 %	0.84	0.87	0.90	0.87
	Furrow	T1	100 %	0.78	0.72	0.72	0.74
			80 %	0.74	0.72	0.79	0.75
			60 %	0.69	0.73	0.71	0.71
		T2	100 %	0.71	0.78	0.73	0.74
			80 %	0.74	0.76	0.69	0.73
			60 %	0.68	0.69	0.70	0.69
		T3	100 %	0.72	0.70	0.77	0.73
			80 %	0.71	0.71	0.74	0.72
			60 %	0.66	0.69	0.72	0.69

Q3 1 : 2 Canal : drainage	Trickle	T1	100 %	1.03	1.01	1.02	1.02
			80 %	1.09	1.06	1,06	1.07
			60 %	0.95	0.97	0.93	0.95
		T2	100 %	1.04	1.01	1.04	1.03
			80 %	1.06	1.00	1.03	1.03
			60 %	0.89	0.87	0.85	0.87
		T3	100 %	1.12	1.16	1.11	1.13
			80 %	1.17	1.20	1.14	1.17
			60 %	0.98	0.99	0.94	0.97
	Furrow	T1	100 %	0.90	0.85	0.83	0.86
			80 %	0.93	0.89	0.85	0.89
			60 %	0.81	0.79	0.86	0.82
		T2	100 %	0.87	0.88	0.92	0.89
			80 %	0.92	0.95	0.98	0.95
			60 %	0.82	0.79	0.79	0.80
		T3	100 %	0.99	0.97	1.04	1.00
			80 %	1.04	1.09	1.08	1.07
			60 %	0.83	0.89	0.92	0.88
Q4 Drainage water	Trickle	T1	100 %	1.21	1.17	1.22	1.20
			80 %	1.24	1.26	1,22	1.24
			60 %	1.01	1.06	0.99	1.02
		T2	100 %	1.11	1.09	1.16	1.12
			80 %	1.21	1.25	1.23	1.23
			60 %	0.98	1.03	1.02	1.01
		T3	100 %	1.05	1.09	1.04	1.06
			80 %	1.16	1.19	1.22	1.19
			60 %	0.97	0.94	0.94	0.95
	Furrow	T1	100 %	0.94	0.92	0.99	0.95
			80 %	1.03	1.00	1.09	1.04
			60 %	0.87	0.89	0.82	0.86
		T2	100 %	0.99	1.08	1.11	1.06
			80 %	1.12	1.17	1.16	1.15
			60 %	0.89	0.87	0.91	0.89
		T3	100 %	1.03	1.06	1.03	1.04
			80 %	1.12	1.12	1.15	1.13
			60 %	0.82	0.89	0.84	0.85