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SEMI MECHANIZATION OF COTTON PRODUCTION IN CALCAREOUS SOIL IRRIGATED BY SALINITY WATER AT BURG EL-ARAB REGION

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ABSTRACT

This work was carried out at Burg El-Arab region in two feedans. Where, the irrigation water is highly salinity. The tested variables were tillage (three levels) and rows spacing (three levels). The forward speed of tractor, draft force of tillage operations, water salinity, water consumption, crop coefficient and yield were measured and recorded. The power of tillage operations was determined.

The results indicated that the ability of cotton seeds to grow with salinity water (mixed between canal and drainage water), where, the average salinity water around the growing season was about 4.5 d.S.m^{-1}.

The results also showed that the system T_2 consumed the lowest power and T_3 consumed the highest power. Where, the power consumption was increased at T_1 and T_2 by 16.36 % and 44.24 % respectively compared with T_3. The highest yield recorded at treatment of 7 shares 2 cross passes followed by rotary tiller (T_2) with 40 – 80 cm rows spacing (D_1), followed by treatment of 7 shares chisel plow 2 cross passes followed by disk harrow and leveler (T_1) with 40 – 80 cm rows spacing (D_1), but the control treatment T_3 (7 shares 3 cross passes followed by disc harrow and leveler) with 90 cm rows spacing (D_3) gave the lowest yield. Where, at T_3 treatment the soil was more harrowing and the seeds were going more deep than the other treatments, this deep seeds are difficult to grow. The consumed irrigation water was increased from May up to August. The irrigation water consumption was decreased after that up to October, where in this period the plants were consumed less water through the flowering, and picking (first and second picking).

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INTRODUCTION

Cotton is considered the most important fiber crop in Egypt. It is considered the back bone of the international income due to the major exported quantities and participates for a great deal in industries. Great efforts have existed to increase and improve cotton quality. In Egypt there are wide area of reclaimed and under reclaiming soils may be invested in producing strategically crops i.e. cotton. Canal water (or clean water) in another word high quality water is unavailable; this is a vital problem facing the producer. This problem may be solved by applying such system in respect to salinity water. So, this research is an attempt to produce cotton in a calcareous soil in Burg El-Arab region.

The irrigation water at Burg El-Arab area is not enough to irrigate agriculture crops (field crops and horticulture) and the farmers in this region suffer from shortage of water especially at tail end of the irrigation canals, for that the source of water is ready salinity water (mixed between canal and drainage). It is main source for irrigation in this region. That causes high salinity of irrigation water, where the quantity of drainage water sometimes is more than canal water (80%). Most of crop have not ability to this salinity water.

In the region of Burg El-Arab area, to study the effect of irrigation by mixed drainage and canal water on cotton yield, some traditional tillage systems by using chisel plow, rotary tiller, disc harrow and scraper, with different rows spacing were used. 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).

The increasing demand for 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 growing season of the crops, even the tolerant ones, does not produce high yield most of times. Mixing agricultural drainage water as well as low quality ground water with good quality river water in ratios to keep the salinity of the irrigation water below the threshold of the target crop is an acceptable practice and is used by many scientists (Pasternak et al., 1996; Suarez and Lebron, 1993; Oster, 1994). When water resources are limited and the cost of non-saline water becomes prohibitive, crops of moderate to high salt tolerance can be irrigated with saline water especially at later growth stages. The irrigation water can be a mixture of saline with non-saline water (blending). Saline water can also be applied in cycles with non-saline water. The use of saline drainage water for irrigation has an environmental advantage. It reduces the non-saline water requirement for salt tolerant crops and it 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 waters of a wide range of quality by appropriately selecting crops, irrigation methods and management practices (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 (or salinity water) for producing cotton crop, solving the problems of irrigation canals at Burg El-Arab region under some traditional tillage systems and different spacing rows for this region.

MATERIALS AND METHODS

This research was carried out in two feddans at Burg El-Arab area (Private farm). The soil texture is sandy loamy type (tables 1-a and 1-b). The irrigation water is high salinity, where the canal water is mixed with drainage water at the source to have enough flow and quantity. Because of the irrigation canal water is not enough for growing plants and mixed with drainage at the water source.

Table 1-a: Soil analysis of experimental soil before investigation.

Depth of soil sample, cm	Sandy %	Loam %	Clay %	texture
0 – 30	60.3	24.5	15.2	Sandy loam
30 - 60	56.7	26.1	17.2	Sandy loam

depth of soil sample, 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	1.5	20	11

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

Depth of sample, cm	**0 - 15**	**15 - 30**	**30 - 45**
$CaCo^3$ %	26.85	31.35	15.45
S.P. %	72.7	45.6	60.0
PH	7.67	7.86	7.96
E.C., ds/m	7.67	7.86	7.96
Na^+, meg/L	22.0	23.8	29.6
K^+, meg/L	1.48	0.71	0.34
Ca^{++}, meg/L	24.2	4.42	2.5
Mg^+, meg/L	41.2	1.3	0.83
Co_3^-, meg/L	0	0	0
$H Co_3^-$, meg/L	2.7	2.6	2.8
Cl^-, meg/L	8.1	5.0	2.3
SO_4^-, meg/L	26.1	0.07	0.06
N, P.P.M.	1439	1434	1386
P, P.P.M.	69.0	6.7	13.0
K, P.P.M.	4.0	11.0	7.2
Fe, P.P.M.	4.1	3.4	5.2
Mn, P.P.M.	2.0	0.8	0.8
Zn, P.P.M.	0.66	0.4	0.32
Cu, P.P.M.	0.88	0.70	0.78

Treatments:-

1- Tillage treatments are:

- Seven shares chisel plow 2 cross passes followed by disk harrow and scraper (T_1)
- Seven shares chisel plow 2 cross passes followed by rotary tiller (T_2)
- Seven shares chisel plow 3 cross passes followed by disk harrow and scraper (T_3), (traditional tillage or farmers treatment in this area - control)

2- Rows spacing are:

- 40 – 80 cm. (D_1)
- 76 cm. (D_2)
- 90 cm. (D_3) (the common distance or farmers treatment in this area in this area - control).

Tillage implements:

- 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, 60 cm clearance, and 25 cm between each two followed shares) was used 2 and 3 cross passes as primary tillage (12, 20, 25 cm plowing depth after first, second and third faces respectively).
- A tandem heavy disc harrow working width is 280 cm, was used as secondary tillage.
- A locally scrapper working width is ten fit (915 cm), was used as secondary tillage to harrowing and leveling soil.
- A rotary tiller working width is 160 cm.
- Two tractors 90 hp (67.14 kW) were used. The front tractor is to measure draft force, and the rear tractor is for mounted chisel plow, trailed disk harrow and scraper.

Planter implements:

- The gohn-deer planter four units were used. This implement can be adjusted the rows spacing easy and the feeding system is mechanical feeding. Also, the seed discs can be changed easy.

Measurements:

- Tractor forward speed through operations by using stopwatch and measure tap.
- Draft force by using hydraulic dynamometer and helping tractor.
- Plowing depth.
- Cotton yield by picking 3 samples from each treatment plot.
- Applied water for the all season.
- The power will be determined from the following formula:

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

Where: P_p = power requirement of pull, kW.

P = net pull force, N. S = forward speed of plowing, m/s.

- Nitrogen utilization efficiency (NUE), potassium utilization efficiency (KUE) and irrigation water utilization efficiency (WUtE) were calculated by the following equations: (Shideed et. al. , 2005)

$$NUE = \frac{\text{cot}\,ton\,.\,fibers\ .\,per\,.\,feddan}{Nitrogen\ .\,fertilizer\ .\,added\ .\,to\,.\,feddan}$$

$$KUE = \frac{\text{cot}\ ton\,.\,fibers\ .\,per\,.\,feddan}{potassium\ .\,fertilizer\ .added\ .to\,.\,feddan}$$

$$WUtE = \frac{\text{cot}\ ton\,.\,fibers\ .\,per\,.\,feddan}{m^3\,.of\ .irrigation\ .water\ .consumption}$$

- **Kc** (Crop coefficient): (Lary, 1988)

Coefficient Kc for a crop is determined experimentally and reflects the physiology of the crop, the degree of crop cover, the location where data were collected and the method used to compute ETo. The Kc variations with location and ETo method is minimized when ETo is reference crop ET. Values of Kc for a fild crop generally increase from an initial growth stages (Lary, 1988).

- **ETo**

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

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

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

Where:

- ETc = Evapotranspiration for 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 analysis:

The yield samples were analyzed by using factorial analysis method. Where, the design of experiment was factorial method.

RESULTS AND DISCUSSIONS

The cotton crop was growing under salinity irrigation water, where the average water salinity was around 4.5 $d.S.m^{-1}$ during the growing season.

Power requirement:

From the data presented in table (1), it is found that the system T_2 (seven shares chisel plow tow cross passes + rotary tiller) consumed the least power, meanwhile T_3 (seven shares chisel plow three cross passes + disc harrow + leveler) consumed the largest power. So, the power consumed by tillage treatment can be arranged in descending order as $T_3 > T_1 > T_2$. The power was decreased at T_1 (seven shares chisel plow tow cross passes + disc harrow + leveler) and T_2 by 16.36 % and 44.24 % respectively compared to T_3.

The obtaining pulverization (W.M.D.) was 0.749, 0.743 and 0.733 cm at T_1, T_3 and T_2 respectively after tillage operations.

Table 1: Forward speeds, draft forces and power requirements of different tillage systems were used.

symbol	Tillage system		Forward speed* km/h	Draft force* kN	Power requirement kW	Total power kW
T_1	7 shares chisel plow	1st face	4.50	9.66	12.08	
	Tow faces +	2nd face	4.14	9.17	10.55	
	Disc harrow +		5.76	8.10	12.96	
	Leveler		6.30	8.19	14.33	**49.92**
T_2	7 shares chisel plow	1st face	4.50	9.66	12.08	
	Tow faces +	2nd face	4.14	9.17	10.55	
	Rotary tiller		5.40	7.11	10.67	**33.30**
T_3 control	7 shares chisel plow	1st face	4.50	9.66	12.08	
	Three faces +	2nd face	4.14	9.17	10.55	
		3ed face	4.00	8.83	9.80	
	Disc harrow +		5.76	8.10	12.96	
	Leveler		6.30	8.19	14.33	**59.72**

* Each item of forward speed and draft force = mean of 10 recorded measures.

Cotton yield:

The cotton yield was represented in table (2), the highest yield was resulted at treatment T_2 (7 shares 2 cross passes followed by rotary tiller) with (D_1) 40 – 80 cm rows spacing, followed by T_1 treatment (7 shares chisel plow 2 cross passes then disk harrow and leveler) with (D_1) 40 – 80 cm rows spacing, but the control treatment T_3 (7 shares 3 cross passes followed by disc harrow and leveler) with (D_3) 90 cm rows spacing (control treatment or farmer treatment) resulted the less yield. Where, at T_3 treatment the soil was more harrowing and the seeds were going deeper than the other treatments, this deeper seeds sre difficult to grow. Also, T_2 more harrowing than T_1 that gave best growing seeds at T_1 and the heist yield. The yield was increased by 24.43 %, 25.34 %, 6.65 % and 7.11 % at T_1 at (40 -80 cm), T_2 at (40 -80 cm), T_1 at (76 cm) and T_2 at (76 cm) compared with T_3 at (90 cm). Can be referred the difference of yield between the difference row spacing to plant number per feedan.

The data analysis by factorial analysis showed that the L.S.D.$_{0.05}$ of tillage treatment is 6.4043. T_1 with T_2 have no significant, but T_1 and T_2 have highly significant with T_3. The L.S.D.$_{0.05}$ of plant rows spacing is 6.4043, the distance of 40–80 cm has highly significant with the rows spacing of 76 cm and 90 cm, and the distance of 76 cm has highly significant with rows spacing of 90 cm. The replicates have no significant, where the analysis of data results shows in table 3.

Table 2: The cotton yield under different systems was used.

Tillage treatment	Rows spacing	Yield samples (kg/fed)			
	cm	1	2	3	mean
T_1	40 – 80	1080	1092	1083	1085
	76	933	922	935	930
T_2	40 – 80	1083	1097	1099	1093
	76	929	938	935	934
T_3 (control)	90	876	857	883	872

Table 3: Shows the data analysis of cotton yield at 0.05.

Treatment	L.S.D.$_{0.05}$	$F_{calculated}$	difference	
Tillage				
T_2	6.4043	675.6		a
T_1		671.6	4.0	a
T_3		290.7	380.9^{**}	b
Rows distance				
40 – 80 cm	6.4043	726.0		a
76 cm		621.3	104.7^{**}	B
90 cm		290.7	330.6^{**}	C
Replicates				
R1	6.4043	544.5		a
R2		544.1	0.4	a
R3		548.3	4.2	a

Irrigation water consumption:

The water consumption and crop coefficient were represented in table (4). Fig. (1) shows the relationship between irrigation water consumption and crop coefficient with irrigation time. The observations showed that the irrigation water consumption was increased from May up to August, where in this period the plants were consumed a lot of water (as showed in table 4) to complete its growth, and decreased after that up to October. Where, in this period the plants were consumed less water through the flowering, and picking (first and second picking).

The crop coefficient has the same trend of irrigation water consumption.

Table 4: showed the water consumption at irrigation time.

Irrigation time	Kc	Water consumption m^3 / fed.	Note
May	0.3	279.22	The average water salinity was around 4.5 $d.S.m^{-1}$ during the growing season.
June	0.5	482.52	
July	0.7	708.10	
August	1.0	916.34	
September	1.1	832.03	
October	0.8	278.21	
Total		3496.42	

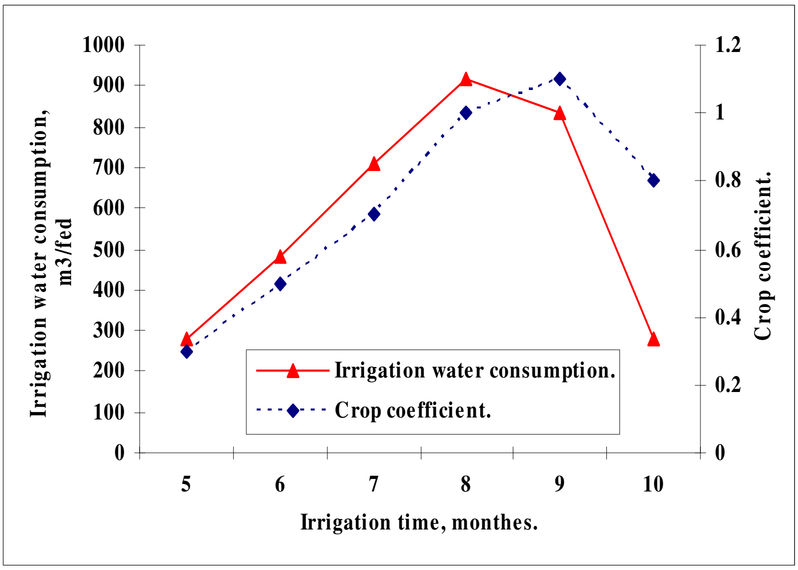

Fig. (1): The relationship between irrigation water consumption and crop coefficient with irrigation time.

Cotton fiber with fertilizer (N and k) and irrigation water consumption affected by tillage treatments:

The chemical fertilizers quantities were fixed at all differences treatments. Table 5 and figure 2 show the relationship between cotton fiber production and fertilizers were uses of N & K, and irrigation water consumption at different tillage systems uses. The cotton fiber production increased by 15.54 %, 16.23 % at T_1, T_2 respectively compared with T_3 for N fertilizer, and 15.52 %, 16.24 % at T_1, T_2 respectively compared with T_3 for K fertilizer. Also, the cotton fiber production increased by 15.56 %, 16.24 % at T_1, T_2 respectively compared with T_3 for irrigation water consumption unit (m^3),

Table 5: NUE , KUE and WUE as affected by T_1, T_2 and T_3

Treatments	NUE (kg fiber / kg N.)	KUE (kg fiber / kg k.)	WUE (kg fiber / m^3 water)
T_1	20.15	41.97	0.2882
T_2	20.27	42.23	0.2899
T_3	17.44	36.33	0.2494

Notes:

NUE = nitrogen use fertilizer (N),

KUE = potassium use fertilizer (K), and

WUE = irrigation water consumption.

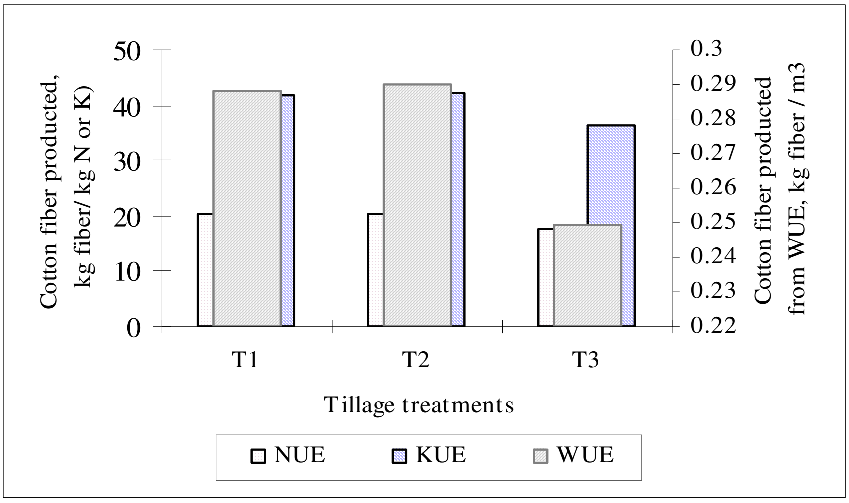

Fig. (2): The relationship between cotton fiber production and fertilizers uses of N & K, and irrigation water consumption at different tillage systems uses.

SUMMERY AND CONCLUSION

This research work was carried out at Burg El-Arab region as newly reclaimed soils, where, the area is suffering from shortage of canal (or fresh) irrigation water. Some different traditional tillage systems were used to prepare the seed bed with different rows spacing.

The results show the ability of cotton crop to grow with salinity water (mixed between canal and drainage waters), where, the average salinity water around season was ranged about 4.5 $d.S.m^{-1}$. The treatment of seven shares chisel plow two cross passes then rotary tiller with rows spacing 40–80 cm gave the highest cotton yield and consumed the less power through tillage operations, followed by treatment of seven shares chisel plow two cross passes then disc harrow and leveler with rows spacing 40–80 cm. But the control treatment seven shares chisel plow three cross passes followed by disk harrow and scraper with rows spacing 90 cm gave the lowest cotton yield and consumed the highest power through tillage operation.

Recommendation

The cotton plant was successfully growing under irrigation by high salinity water (mixed between canal water and drainage water, about 80 % drainage water)), with preparing soil by chisel plow 2 cross passes followed by rotary tiller and rows spacing 40 – 80 cm or preparing soil by chisel plow 2 cross passes then disc harrow and leveler with rows spacing 40 – 80 cm at Burg El-Arab area. Where, these conditions consumed the least power and gave the highly yield in this reigon.

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الملخص العربى

الميكنة الجزئية لأنتاج القطن فى الأراضى الكلسية رياً بماء عالى الملوحة فى منطقة برج العرب

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أجرى هذا البحث فى منطقة برج العرب (مزرعة خاصة) على مساحة 2 فدان حيث أن طبيعة الأرض من النوع الكلسى ، وحيث أن المنطقة تعانى من نقص مياه الرى فإن إدارة الرى تستعيض عن نقص مياه الرى بإضافة وخلط مياه الصرف الزراعى مع مياه الترع لزيادة كمية المياه والحفاظ على معدل التصرف مما يؤدى إلى زيادة ملوحة مياه الرى حيث أن نسبة ماء الصرف المضافة قد تفوق نسبة ماء الترع (تصل إلى 80 ٪) حيث كانت ملوحة مياه الرى المخلوطة على مدار الموسم 4.5 $d.S.m^{-1}$.

وقد أظهرت النتائج أن محصول القطن قد أستجاب للزراعة والنمو فى ظروف الرى بماء مخلوط عالى الملوحة، وأن معاملة الحرث بالمحراث الحفار 7 سلاح وجهين متعامدين متبوع بالمحراث الدورانى قد أستهلكت أقل قدرة، تليها معاملة الحرث بالمحراث الحفار 7 سلاح وجهين متعامدين متبوع بالمشط القرصى ثم القصابية، وأن معاملة المحراث الحفار 7 سلاح 3 أوجهه متعامدة متبوع بالمشط القرصى ثم القصابية (الحرث التقليدى للمزارعين بالمنطقة) قد أستهلكت أعلى قدرة، كما أن معاملة الحرث بالمحراث الحفار 7 سلاح وجهين متعامدين متبوع بالمحراث الدورانى مع مسافات بين خطوط الزراعة 40 – 80 سم قد أعطت أعلى أنتاجية يليها المعاملة محرث حفار 7 سلاح وجهين متعامدين متبوع بالمشط القرصى ثم القصابية مع مسافات بين خطوط الزراعة 40 – 80 سم. وأن أدنى أنتاجية كانت عند المعاملة محراث حفار 7 سلاح 3 أوجهه متعامدة متبوع بالمشط القرصى ثم القصابية ومسافة بين خطوط الزراعة 90 سم (المتبع للمزارعين بالمنطقة) كما أنها أستهلكت أعلى قدرة أثناء عمليات الحرث وتجهيز التربة. هذه النتائج أوضحت أنه **يمكن زراعة القطن تحت ظروف الرى بماء عالى الملوحة (مخلوط من ماء الترع وماء الصرف الزراعى) بظروف المنطقة المذكورة**.

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