SALINE WATER MANAGEMENT FOR TOMATO PRODUCTION UNDER GREENHOUSES AT NORTH NILE DELTA, EGYPT

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ABSTRACT

Two experiments were cultivated by tomato (variety Ebeza) in greenhouse (clayey soil)at Sakha Agricultural Research Station, Kafr El-Shiekh governorate , Egypt during 2002 season to study the different water sources (fresh water (0.53dS/m), well water (3.1dS/m) and alternative well water with fresh water under surface and subsurface drip irrigation in the first experiment. While different artificial water salinity levels (2, 4, 6, 8, 10, 12 and 14 dS/m) under surface drip irrigation were conducted in the second experiment.

The following results are the main findings:

Irrigation with fresh water achieved the highest fruit yield of tomato, yield per plant, juice percentage and vitamin C. While the yield of tomato is decreased by 11.48 and 25.71% when irrigated by alternative well water with fresh water and well water respectively.

Subsurface drip irrigation increased the yield of tomato by 8.57%.

The relative yield of tomato is reduced from 29.65 to 75.96% with increasing water salinity levels from 2 to 14 dS/m.

The highest value of water application, water use and water utilization efficiencies were achieved with irrigation by fresh water under subsurface drip irrigation.

Seasonal crop coefficient values for tomato under greenhouses were found to be 0.84, 0.66, 0.56 and 0.72 for modified Blaney and Criddle, pan evaporation, modified Penman and Penman – Monteith.

The salt accumulation in top soil tend to increase under surface drip irrigation compared to subsurface drip irrigation and with increasing the salinity of irrigation water.

Key words: Tomato- Greenhouse- saline water- irrigation efficiency.

INTRODUCTION

Because of water scarcity problems in arid regions, it has become of primary importance to search for alternative sources of water for agricultural irrigation. Brackish water can be used for irrigation of various crops. In spite of the fact that saline water used for agriculture is associated with some reduction in yield, it can successfully be applied to irrigation, coupled with improved irrigation technology such as subsurface drip irrigation. When brackish water is skillfully used for irrigation, it can contribute to the successful production of crops (*Mizrahi and Pasternake, 1985*).

However, applying saline water continuously for irrigation through surface drip irrigation system results in salt accumulation close to the soil surface. This process might inhibit water and nutrient uptake, affecting the crop growth and yield (Hanson, 1995).Controlling applied water rates, chemical fertilizers and herbicides under subsurface drip irrigation system gained valuable advantages such as saving irrigation water, chemical fertilizers and herbicides.

The subsurface drip irrigation system ensure high and efficient supply of water and fertilizer to plant at the effective root zone which is reflected in high yield (EL–Berry ,1989).

The use of subsurface drip irrigation system provided great potential for vegetable production in arid areas. In addition to higher expected yield, it reduced crop management costs and water demands (*EL–Berry et al., 1990)*.

Total water requirements after transplanting tomato crop grown in the field for 90 to 120 days are 400 to 600 mm depending on the climate ***(Doorenbos and Kassam ,1986)***.

Abo- Soliman et al. (1996) indicated that a slight decrease in amount of irrigation water applied under subsurface drip method as compared to surface drip method.

Tallat et al. (2002) revealed that plant growth parameters, total soluble solids of fruit and yield of tomato were significantly decreased by increasing soil salinity. Moreover, subsurface irrigation recorded the highest values of the studied parameters followed by drip irrigation.

Phene et al. (1991) and *EL – Morsy (1996)* found that the highest crop yield and water use efficiency were achieved using subsurface trickle irrigation for tomato .

Koriem (1988) found that accumulation of salts decreased with depth under plastic tunnels while the opposite trend was clear under the open conditions.

Tallat et al., (2002) revealed that drip irrigation caused a considerable increase of salinity build–up followed by subsurface irrigation. Also, it was observed that water application display a remarkable increase of soil salinity build in the order saline water > cyclic low salt concentration water.

The objectives of the present investigation were:

1- To evaluate the irrigation by different water sources under drip irrigation system (surface and subsurface).
2- To study the response of tomato plants to irrigation with different levels of salinity under surface drip irrigation.

MATERIALS AND METHODS

Two experiments were carried out during season of 2002 inside plastic greenhouse located at Sakha Agricultural Research Station, Kafr El-Shiekh governorate, North Delta region, Egypt. The site has an elevation of 6 meter above sea level with latitude of 31° 07' and longitude of 30° 52' . The soil was clayey with shallow water table (70 cm). The greenhouse dimensions were 23-meter length and 2 meter width for each treatment. Tomato cultivar (Lycopersion esculentum, L) variety Ebeza was transplanted on Jan. 1st 2002. The soil of the greenhouse was divided into four wide furrows, each one meter width. Each furrow had two irrigation laterals. A split plot design with four replicates was used for the first experiment. Water sources i.e. fresh water (F), Well water (W) (from local well) and alternative well water with fresh water (W, F) were assigned to the main plots, whereas, the two drip irrigation system ;surface (Sd) and sub-surface (SSd installed at 25 – 30 cm depth from soil surface) with 4L/hr. discharge of each emitter were allocated in sub-plots. Tables (1a & 1b) presents the analysis of soil and irrigation water.

Table (1a): Average values of some physical and chemical properties of soil under plastic tunnels.

Soil depth (cm)	Particle size distribution			Texture class	O.M. %	PH 1:2.5	EC dS/m 25 C	Bulk density g/cm³	Soil moisture characteristics		
	sand %	Silt %	clay %						FC %	W.P %	Available water
0-60	21.67	27.93	50.40	Clayey	0.87	8.04	6.53	1.22	40.94	22.88	18.06

Table (1b): Chemical analysis of different water sources.

Water Sources	EC dS/m 25C	Anions meq/L				Cations meq/L				SAR
		$CO_3^{=}$	HCO_3^-	Cl^-	$SO_4^{=}$	Ca^{++}	Mg^{++}	Na^+	K^+	
Fresh water (F)	0.53	0.0	1.2	1.8	2.2	1.7	1.0	2.0	0.5	1.72
Well water (W)	3.1	0.0	5.6	14.7	10.7	6.6	5.5	17.6	1.3	7.15

The design of the second experiment was randomized complete blocks with three replicates and irrigated by different levels of artificial saline water (2, 4, 6, 8, 10, 12 and 14 dS/m)was prepared by mixing NaCl with $CaCl_2$ salts at certain ratios (SAR = 10) under surface drip irrigation system.

All the other agronomic practices including pest control and fertigation carried out according to the MALR recommendations. Harvesting of tomato continued to the 2nd of July.

The studied parameters:

- Fruit yield and chemical composition of tomato:
  The mature fruits were picked from all plants within each plot once a week to measure the total yield (kg) and weight of fruits per plant were calculated from the whole yield. Juice of the representative samples (20 fruits) was taken for measuring fruit quality. It was extracted, estimated and used for determination of ascorbic acid, total soluble solids (%) and total acidity according to *A.O.A.C. (1970)*. Data were statistically analyzed according to *Snedecor and Cochran (1967)*.
- The quantities of water for each irrigation was calculated when 40% of the available soil moisture was depleted according to the following equation: (*Israelson and Hansen, 1962*).

$$Q = R \times D \times \frac{Bd \times F.C. - S.M.I.}{100}$$

Where:

Q : the quantity of water, m^3.
R : Area that would be irrigated, m^2.
D : the soil depth required to be irrigated, m.
Bd. : soil bulk density, g/cm^3.
F.C. : field capacity %.
S.M.I. : Soil moisture percentage just before irrigation.

- **Actual water consumptive use (ETa):**

  It was determined as the differences in soil moisture content in the soil samples taken before and after the next irrigation from four successive soil depths, 0-15, 15-30, 30-45 and 45-60 cm. Moisture content in the soil samples was determined gravimetrically and calculated on dry basis (*Garcia, 1978*). Water depth was estimated according to *Israelson and Hansen (1962).*

- **Water application efficiency:**

  Was calculated using the following equation as described by *Downey (1971)*.

  Ea= water stored (cm)/ water delivered cm) x 100

- **Potential evapotranspiration (ETp):**
  It was calculated according to *Doorenbos and Pruit (1977)* by four different formula
  - Modified Blaney & Criddle
  - Modified Penman .
  - Pan evaporation Method
  - Penman – Monteith.

- **Crop Coefficient (Kc):**
  Tomato coefficient was calculated as: **Kc= Eta/ETp**
  Where:

  ETa= Actual evapotranspiration in mm/day.
  ETp= Potential evapotranspiration in mm/day.

- **Water use efficiency:**
  It was calculated according to the following equation (***Michael, 1978***)

  WUE = Yield (kg/fed.)/Seasonal water consumptive use (m^3/fed.)

- **Water utilization efficiency (WUtE):**

  WutE= yield (kg/fed.)/amount of water applied (m^3/fed.) *(Michael, 1978).*

- **Salt Movement:**
  Salt movement was calculated as the differences between the mean values of EC (dS/m) for soil layers (0-20, 20-40 and 40-60 cm) before the first irrigation and after the last irrigation (***Black, 1965).***

Table (2): Meteorological data of Sakha Agriculture Research Station in 2002 season.

Months	Mean air Temp. C°	Relative humidity %	Wind speed km/day at 2 m	Solar radiation cal./cm^2/day	Evaporation cm/day
Jan.	10.7	80	137.0	266.18	0.166
Feb.	13.3	80.5	167.0	347.54	0.254
March	15.1	77.0	151.0	402.88	0.361
April	17.5	70.4	160.0	397.51	0.473
May	22.0	66.4	164.0	443.36	0.697
June	25.1	69.4	167.0	449.14	0.772
July	27.7	72.3	177.0	408.46	0.769

RESULTS AND DISCUSSIONS

A. Effect of different water sources and drip irrigation system on :

A.1. Yield and its quality:

The fresh fruit yield as affected by different treatments is shown in Table (3). Data indicate that there was a highly significant effect of different water qualities and drip irrigation system on yield and its quality. Irrigation with fresh water achieved the highest values of fruit yield, yield per plant, juice and vitamin C.

The relative yield of tomato fruit is reduced significantly by 11.48 and 25.71 % due to use of saline water in irrigation for treatments alternative irrigation by well water with fresh water and well water respectively. It is clear from data that irrigation by well water caused significant differences in fruit quality especially total soluble solids and total acidity.

The decrease in yield with well water may be due to salt accumulation close to the soil surface. This process might inhibit water and nutrient uptake, affecting the crop growth and yield ***(Hanson, 1995).***

Using subsurface drip irrigation increased fruit yield by 8.57% compared to conventional surface drip irrigation ***(El-Morsy, 1996***).

Measuring of tomato fruit chemical properties indicate that subsurface drip irrigation increased yield per plant, juice % and vitamin C by 8.63, 13.69 and 11.86 %, respectively compared to surface drip irrigation. However the surface drip irrigation system increased total soluble solids and total acidity by 7.11 and 4.8 %, respectively compared to subsurface drip irrigation. This results are in agreement with those obtained by ***Tallat et al. (2002).***

Concerning the interaction, data indicate that there was interaction effect between different water qualities and drip irrigation system on Juice, Vitamin C, total soluble solids and total acidity.

Table (3): Tomato fruit yield and its chemical properties as affected by water sources and drip irrigation system under plastic tunnels.

Treatments	Commercial yield (kg)	Yield/plant (kg)	Juice(%)	Vitamin C (mg/100 cm^3)Juice	TSS (%)	Total acidity (mg/100 cm^3)Juice
Water Sources (S)						
Fresh (F)	236.92	4.94	80.76	22.00	5.93	460.88
Well (W)	176.01	3.67	77.61	20.15	6.90	494.25
Fresh alt. Well (F alt.W)	209.71	4.37	78.75	21.30	6.29	475.00
F test	**	**	**	**	**	**
L.S.D. 0.05	2.45	0.183	0.44	0.306	0.08	9.25
0.01	3.71	0.280	0.67	0.460	0.12	13.99
Drip irrigation system (D)						
Surface (Sd)	198.25	4.13	77.53	20.36	6.61	488.42
Subsurface (SSd)	216.84	4.52	80.56	23.10	6.14	465.00
F test	**	**	**	**	**	**
L.S.D. 0.05	2.11	0.150	0.11	0.225	0.071	1.48
0.01	2.90	0.210	0.15	0.309	0.097	2.04
Interaction						
S × D	n.s	n.s	**	**	*	*

A.2.Some water relations:

A.2.1. Amount of water applied and actual water consumptive use :

Depth of water applied and consumed values are presented in Table (4). The highest values of water applied and consumed (60.31 and 54.06 cm) were recorded with irrigation by fresh water under surface drip irrigation . While the lowest values (49.47 and 42.9 cm) for depth applied and consumed water , respectively were obtained with irrigation by well water under subsurface drip irrigation . The results show that the amount of irrigation water applied can be saved by 3.35 , 10.01 and 5.53 % for fresh water , well water and alternative well water with fresh water respectively . These results agreed with those obtained by El-Berry et al., (1990) and Ab0- Soliman et al., (1996).

Table (4): Some water relations as affected by different water sources under drip irrigation system in plastic tunnels.

Treatments	Total yield of tomato (kg)		Depth of water applied (cm)		Water saving %	Depth of water consumed(cm)		Water application efficiency %		Water use efficiency (kg/cm)		Water Utilization efficiency (kg/cm)	
	Surface Drip	Subsurface drip	Surface Drip	Subsurface drip		Surface Drip	Subsurface drip	Surface Drip	Subsurface drip	Surface Drip	Subsurface drip	Surface Drip	Subsurface drip
Fresh water	223.06	250.77	60.31	58.29	3.35	54.06	51.84	86.76	88.93	4.13	4.84	3.7	4.30
Well water	170.94	181.08	54.97	49.47	10.01	45.86	42.9	83.43	86.72	3.73	4.22	3.11	3.66
F alt. W	200.75	218.69	56.75	53.61	5.53	47.62	46.83	83.91	87.35	4.22	4.67	3.54	4.08

Table (5): Monthly actual (ETa) and potential evapotranspiration (ETp) and monthly crop coefficient (Kc) during the growing season.

Months	ETa	Blaney – Criddle		Pan evaporation		Modified Penman		Penman-Monteith	
		ETp	*Kc*	*ETp*	*Kc*	*ETp*	*Kc*	*ETp*	*Kc*
Jan.	1.91	3.72	0.51	4.37	0.44	6.6	0.29	4.34	0.44
Feb.	3.58	4.65	0.77	6.05	0.59	8.01	0.45	5.32	0.67
March	6.25	6.82	0.92	9.51	0.66	11.99	0.52	8.68	0.72
April	9.46	9.60	0.99	12.06	0.78	13.89	0.68	11.4	0.83
May	14.09	13.33	1.06	17.30	0.81	18.41	0.77	15.5	0.91
June	13.2	15.09	0.87	18.54	0.71	20.1	0.66	17.1	0.77
July	3.98	5.23	0.76	6.54	0.61	6.92	0.58	5.9	0.67
Average	7.50	8.35	0.84	10.62	0.66	12.27	0.56	11.52	0.72

A.2. 2. Water application efficiency (Ea) :

Data in Table (4) reveal that the water application efficiency values were 86.76 , 83.43 and 83.91 % for fresh water , well water and alternative well water with fresh water respectively under surface drip irrigation . Whereas under subsurface drip irrigation, the respective values were 88.93, 86.72 and 87.35 % for fresh water, well water and alternative well water with fresh water respectively. It can be concluded that subsurface drip irrigation improved water application efficiency compared to surface drip irrigation.

A.2.3. Efficiency of water use and water utilization :

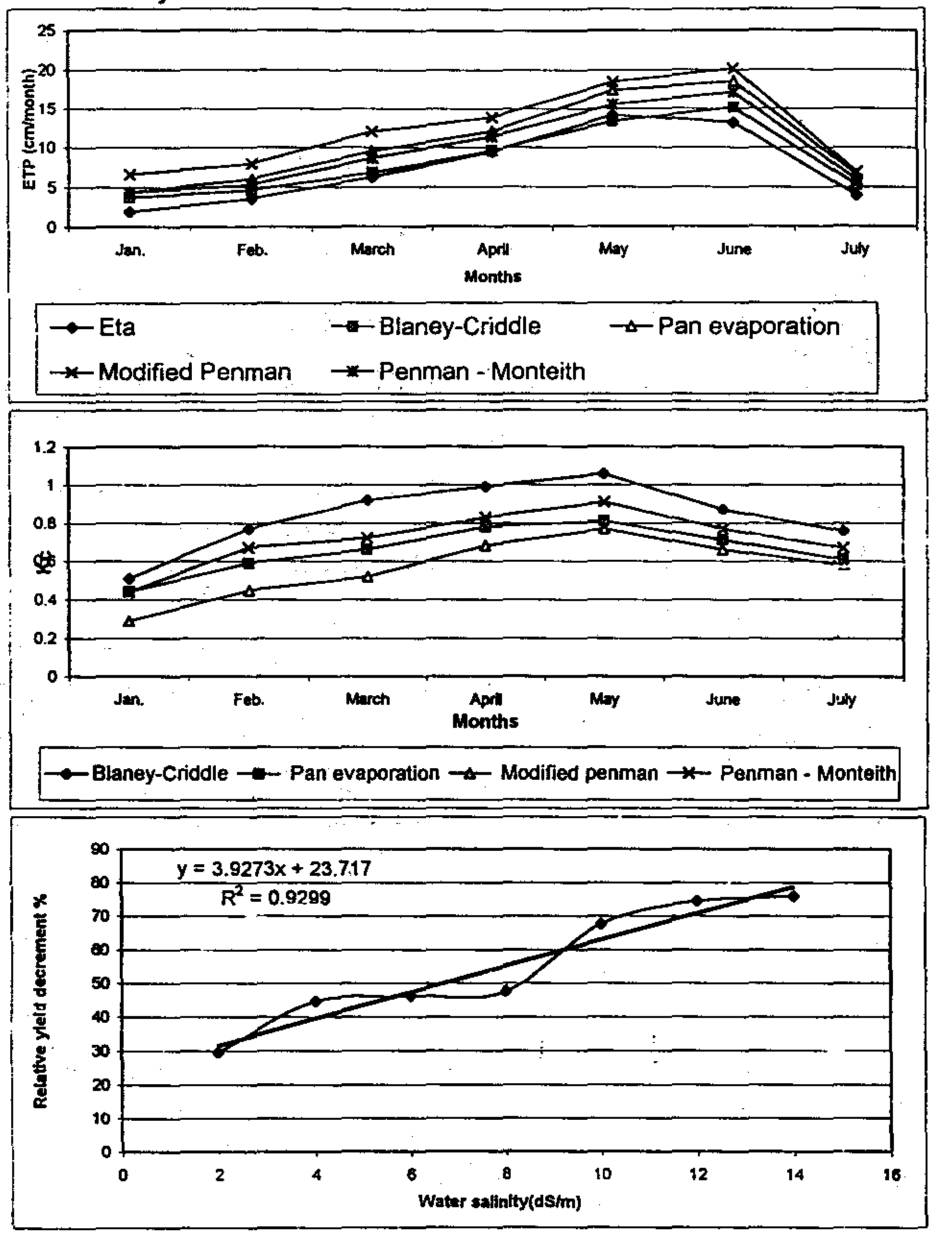
Data in Table (4) show that the maximum water use and utilization efficiencies (4.84 and 4.3 kg / cm) was obtained with irrigation by fresh water under subsurface drip irrigation followed by alternative well water with fresh water under the same method of irrigation . While the lowest values (3.73 and 3.11 kg/cm) for water use and water utilization efficiency ,respectively were recorded with irrigation by well water under surface drip irrigation . The increase in water use and utilization efficiencies values under the stated treatments may be attributed to the reduction in water applied, consumed and higher yield. Similar results were obtained by Phene et al., (1991) and El-Morsy (1996).

A.2.4. Crop Coefficient (Kc):

Crop coefficient (Kc) is presented in Table (5) and Fig.(1) to account the effect of crop characteristics on crop water requirement. It relates potential evapotranspiration (ETp) to crop consumptive use (ETa) computed through the soil moisture depletion by tomato during the growing season. As shown from data, values of crop coefficient (Kc) were calculated according to the actual evapotranspiration (ETa) of tomato plants which irrigated by fresh water under surface drip irrigation to potential evapotranspiration.

In this study, potential evapotranspiration has been estimated by the following methods; modified Blaney-Criddle, pan evaporation, modified Penman and Penman-Monteith during the growth period of tomato. The average values of seasonal crop coefficient (Kc) for tomato were 0.84, 0.66, 0.56 and 0.72 for modified Blaney-Criddle, pan evaporation, modified Penman and Penman-Monteith, respectively. It is clear that, seasonal (Kc) values calculated by Penman-Monteith method was similar to those obtained by Khalifa et al. (1992) and Abo-Soliman et al. (1996).

Fig. (1): Actual (Eta). potential (Etp) in (cm/month) and crop coefficient (kc) and Relative yield decrement %



A.3. Salt accumulation and its distribution with variable soil depths:

The distribution of salts at different depths and rate of change before cultivation and after harvesting tomato with different water sources using surface and subsurface drip irrigation are given in Table (6).

Data declare that the soil salinity increased in the soil surface layer as a result of irrigation with different water sources under both drip irrigation system compared to those obtained before cultivation tomato. While soil salinity increased in the subsurface layer and then decreased in the deepest layer .

It can be concluded that the salt accumulation was obviously in the deepest layer with treatments irrigated by either well or alternated with fresh water under subsurface drip irrigation

Table (6): Effect of different water sources on salt accumulation under surface and subsurface drip irrigation.

Treatments	Depth (cm)	Surface drip irrigation soil salinity (dS/m)			Subsurface drip irrigation soil salinity (dS/m)		
		Before experiment	*After harvesting*	*Rate of change %*	*Before experiment*	*After harvesting*	*Rate of change %*
Fresh (F)	0-20	6.86	7.8	12.0	6.35	7.00	9.35
	20-40	6.01	6.5	7.54	6.15	7.00	12.44
	40-60	4.54	4.8	5.33	4.4	4.90	10.24
Mean		5.64	6.37	8.29	5.63	6.3	10.53
Well (W)	0-20	7.79	9.10	18.49	7.03	8.40	16.3
	20-40	8.67	9.70	10.60	7.25	8.90	18.5
	40-60	6.69	7.0	4.35	5.34	6.70	20.3
Mean		7.7	8.6	11.15	6.54	8.0	18.37
*F alt W	0-20	6.75	8.0	15.59	6.75	7.70	12.4
	20-40	6.88	7.5	8.33	6.17	7.2	14.3
	40-60	5.11	5.4	5.45	4.55	5.50	17.2
Mean		6.25	6.97	9.99	5.82	6.8	14.63

B. Effect of water salinity under surface drip irrigation on:

B.1. Yield and its quality:

Data in Table (7) reveal that water salinity significantly affected on total yield of tomato, yield per plant, juice, vitamin C, total soluble solids and total acidity.

The relative yield of tomato fruit is reduced significantly by 29.65, 44.62, 46.18, 47.57, 67.52, 74.45 and 75.96 % due to increased the salinity in irrigation water (2, 4, 6, 8, 10, 12 and 14 dS/m, respectively) as compared to fresh water. Data show that the Juice percentage decreased with increasing saline water from 80.0 at EC_w 2dS/m to 73% for EC_w 14 dS/m. While vitamin C and total acidity values were increased with increasing salinity level in irrigation water up to 8 dS/m and then decreased with increasing salinity levels up to 14 dS/m. Although the total soluble solids increased with increasing saline water levels.

Table (7): Tomato fruit yield and chemical properties as affected by different saline water under surface drip irrigation in plastic tunnels.

Treatments	Commercial yield (kg)	Yield/ plant (kg)	Juice (%)	Vitamin C (mg/100 cm³)Juice	TSS (%)	Total acidity (mg/100 cm³)Juice
Fresh Water	223.06	4.65	80.77	22.0	5.93	460.9
EC_w 2 dS/m	156.9	3.27	85.00	19.28	5.77	460.5
EC_w 4 dS/m	123.54	2.57	81.25	20.10	6.30	476.0
EC_w 6 dS/m	120.05	2.50	78.50	21.15	6.73	490.5
EC_w 8 dS/m	116.95	2.44	76.00	22.35	7.10	474.8
EC_w 10 dS/m	72.44	1.51	74.25	20.65	7.35	460.5
EC_w 12 dS/m	57.00	1.19	73.50	19.53	7.70	451.3
EC_w 14 dS/m	53.62	1.12	73.00	19.10	7.75	451.3
F. test	**	**	**	**	*	**
L.S.D. 0.05	6.9	0.140	0.95	0.36	0.15	9.41
0.01	9.47	0.195	1.3	0.49	-	12.9

B.2. Regression correlation between relative decrement of tomato and salinity levels of irrigation water.

Data of relative decrement of yield versus water salinity levels were evaluated throughout linear equation for tomato as shown in Fig. (2).

The relative yield decrement % represent the dependant variable while the salinity expressed in EC dS/m represent the independent variable and the equation takes the form $Y = ax + b$

Where:

Y : relative decrement %,
X : salinity of irrigation water
a : slope (yield reduction % with increasing ECw by one unit)
b : The intercept

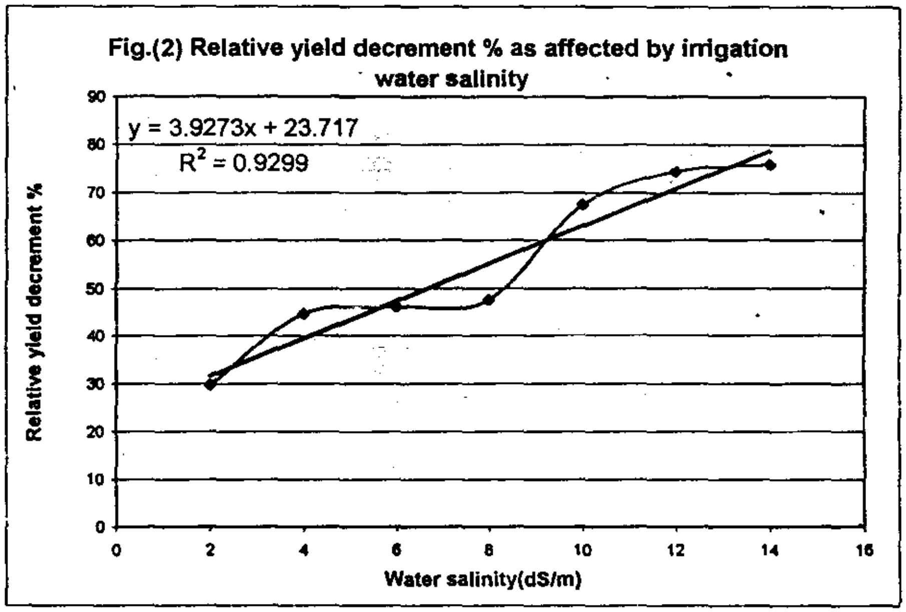


Fig.(2) Relative yield decrement % as affected by irrigation water salinity
y = 3.9273x + 23.717
R2 = 0.9299
Relative yield decrement %
Water salinity(dS/m)
0
10
20
30
40
50
60
70
80
90
0
2
4
6
8
10
12
14
16

The regression equation that fit the interaction is: **Y= 23.717+3.9273X**

where:

Y= predicted seasonal yield (kg)
X= water salinity (dS/m)

It is clear that highly significant correlation was seen between relative yield decrement and water salinity levels (R^2= 0.93).

B.3. Some water relations :

B.3.1. *Depth of water applied and consumed:*

Depth of water applied and consumed are presented in Table (8). It has been noticed that, as the salinity of irrigation water increased, the depth of water applied and consumed were decreased . Data indicate that, irrigation with salinity of 2 dS/m received the highest amount of water applied and consumed, while with high salinity of irrigation water levels (10, 12 and 14 dS/m) were utilized the lowest amount of water . Generally, it is obvious that the treatment. Which received more depth of water applied and consumed produced higher fruit yield of tomato.

Table (8): Total yield of tomato (kg) and some water relations as affected by saline water .

Treatments	Total yield of tomato (kg/plot)	Depth of water consumed (cm)	Depth of water applied (cm)	Water use efficiency kg/cm	Water utilization efficiency kg /cm
EC_w 2 dS/m	156.9	49.62	55.26	3.16	2.84
EC_w 4 dS/m	123.54	44.91	50.63	2.75	2.44
EC_w 6 dS/m	120.05	44.33	49.33	2.71	2.43
EC_w 8dS/m	116.95	43.43	48.19	2.69	2.43
EC_w 10dS/m	72.44	37.61	44.12	1.93	1.64
EC_w 12 dS/m	57.0	37.24	43.62	1.53	1.31
EC_w 14dS/m	53.62	36.59	42.95	1.47	1.25

B.3.2 *Water use and utilization efficiencies:*

Table (8) show the water use and utilization efficiencies in kilogram of tomato per centimeter depth of water consumed or applied as influenced by different treatments through the season of growth. Irrigation with saline water of 2 dS/m achieved the highest values of water use and utilization efficiencies while they reduced by increasing of salinity in irrigation water up to 14 dS/m.

B.4. Salt accumulation and distribution with variable depth:

The rate of change of soil salinity at different depths after irrigation with water of various degree of salinity are presented in Table (9).

Table (9): Effect of irrigation water salinity on soil salinity and the rate of change (%) under tomato in plastic tunnels.

Treatments	Depth (cm)	Soil salinity dS/m		
		Before exp.	*After harv.*	*Rate of change %*
EC_w 2dS/m	0-20	7.30	8.10	10.96
	20-40	7.06	7.70	8.31
	40-60	6.15	6.30	+2.32
Mean		6.84	7.37	7.2
ECw 4dS/m	0-20	7.99	9.3	13.91
	20-40	7.78	8.62	9.72
	40-60	7.3	7.45	2.05
Mean		7.69	8.46	8.56
EC_w 6dS/m	0-20	7.70	9.30	20.78
	20-40	6.20	7.20	10.13
	40-60	6.72	7.20	6.63
Mean		6.87	7.9	14.51
EC_w 8dS/m	0-20	8.1	10.5	29.63
	20-40	6.3	7.4	17 46
	40-60	5.8	6.3	8.62
Mean		**6.73**	**8.07**	**18.57**
EC_w 10dS/m	0-20	9.21	12.8	38.98
	20-40	7.32	9.70	24.56
	40-60	7.57	9.60	21.18
Mean		8.03	10.7	28.24
EC_w 12dS/m	0-20	8.24	15.30	46.12
	20-40	7.17	11.10	35.42
	40-60	7.37	9.90	25.59
Mean		7.59	12.1	35.71
EC_w 14 dS/m	0-20	8.39	16.50	49.15
	20-40	9.41	14.30	34.18
	40-60	9.27	13.30	30.24
Mean		8.64	14.7	37.86

Data indicate that the EC values increased in proportion to the level of salinity water, roughly 1.19, 2.02 , 2.6 , 3.9 , 4.9 and 5.29 times under surface drip irrigation . Irrigation with high saline water recorded the highest EC value (16.5 at 14 dS/m) in the surface layer , followed by the subsurface layer and finally the lowest values were recorded for the deepest layers.

It could be concluded that to use saline water through subsurface drip in irrigated tomato under protected greenhouse of clayey saline soils at North Delta to optimize the yield of tomato per unit of water applied and alleviate the salinity hazard.

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