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RESPONSE OF SUGAR BEET YIELD, QUALITY AND WATER RELATIONS TO SOIL SALINITY AND DROUGHT.

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ABSTRACT

Field experiments were conducted at Tameia district, Fayoum Governorate, Egypt during 2004/2005 and 2005/2006 seasons to study the effect of salinity and drought on sugar beet yield and its components, yield quality and some water relations of the crop. To achieve these objectives, three soil salinity levels, i.e. S_1:4.0, S_2: 9.8 and S_3: 13.5 dS/m were combined with three irrigation regimes, i.e. irrigation at (I_1): 35%, (I_2):55% and (I_3): 75% available soil moisture depletion (ASMD), in a split- plot design with four replications. The main obtained results were as follows:

1-Root length, root diameter, root weight, whole plant weight and fresh root yield/fed. were significantly affected by soil salinity levels and irrigation regime treatments in both seasons.

2-Soil salinity level of 4.0 dS/m and irrigation at 35% ASMD gave the highest root diameter and weight, whole plant weight and fresh root yield/fed. (23.50 and 26.0 t/fed. in 2004/2005 and 2005/2006 seasons, respectively). However, the lowest ones were detected from high salinity level (13.5 dS/m) and irrigation at 75%ASMD in both seasons.

3-Increasing soil salinity level over 4.0 dS/m or increasing ASMD from 35% to 55% or 75% significantly decreased root yield and its components in both seasons, except root length.

4-The highest sucrose percentages, i.e. 20.33 % and 19.47% and sugar beet yield , i.e. 4.77 and 5.06 t/ fed. were obtained from salinity level of 4.0 dS/m and irrigation at 35% ASMD in first and second seasons, respectively.

5-Seasonal consumptive use (ETc) averaged 58.53 and 59.75 cm in 2004/2005 and 2005/2006 seasons, respectively .Increasing soil salinity level from 4.0 to 13.5 dS/m and increasing ASMD from 35% to 75% decreased seasonal ETc from 61.82 and 61.44 cm to 55.55 and 55.70 cm in the two successive seasons .

6-Daily ETc rate started with low values, then increased during Dec., Jan., to reach its maximum values during March, then declined at April and May. The crop coefficient (Kc) during the growing season duration months from Oct., until May was 0.52, 0.71, 0.88, 1.14, 1.28, 1.08, 0.69 and 0.55, respectively, as an average of the two seasons.

7-The highest water use efficiency values, i.e. 8.58 and 9.28 kg fresh roots/m^3 water consumed were obtained from soil salinity of 4.0 dS/m and irrigation at 35% ASMD in the two successive seasons

KeywordS: Sugar beet, Yield, Yield component, Quality, Salinity, Water relations.

INTRODUCTION

Sugar beet (*Beta vulgaris* L.) is the second important sugar crop in the world after sugar cane crop. Soil salinity is one of the problems which limited the crops production. Determining the optimum soil moisture for irrigating sugar beet crop in saline soils to obtain economic yield is very essential for the water management of the crop cultivate in such soils. Doorenbos *et al*. (1979) reported that yield decreases are 0, 10%, 25%, 50%

and 100% at ECe 7, 8.7, 11.0, 15.0 and 24.0 mmohs/cm, respectively. Garyg (1987) indicated that satisfactory growth and production were obtained at 32 ESP. Lindhauer *et al*. (1990) showed that soil salinity caused significant reduction in roots and shoot characters of sugar beet plant. EL-Samnoudi and Abou-Arab (1997) concluded that increasing soil salinity led to severe reduction in plant growth and yield. The more pronounced effect was detected at ECe more than 12.0 dS/m, which indicated the hazard and deteriorating effect of soil salinity. Also, soil salinity over 12.0 dS/m caused severe reduction in beet root quality. Kamel (1999) found that increasing soil salinity led to significant reduction in emergence percentage, root length and diameter, root and whole plant weight, root yield/fed., sucrose, T.S.S and Juice purity percentages, as well as sugar yield/fed. Mekki and EL-Gazzar (1999) revealed that irrigating sugar beet plants with water of 2500 ppm salinity gave the highest root yield, root diameter and whole plant dry weight. Irrigating with water of 7500 ppm salinity gave higher sucrose and T.S.S percentages, but juice purity % and sugar yield were reduced. Ali *et al.* (2002) reported that increasing salinity increased leaf Na content and decreased K content, indicating that plants replaced most of the K with Na in the leaves.

Regarding the effect of irrigation, Prasad *et al*. (1985) indicated that the maximum sugar yield (6.3 t/ha) was obtained from irrigating sugar beet at 80% available soil moisture (ASM). Brown *et al.* (1987) reported that early drought affected fibrous root severely, roots development and leaf canopy expansion slowed and transpiration reduced. Sugar yields were 8.7, 10.5, 9.9 and 12.0 t/ha in the early drought, late drought, un-irrigated (depend on rain) and irrigated treatments, respectively .Semaika *et al.* (1988) revealed that the highest length and diameter of roots were obtained from irrigation at 40% available soil moisture depletion (ASMD). Khafagi and EL-Lawendy (1997) concluded that decreasing irrigation frequency decreased roots weigh, root length and carbohydrate concentration in roots. Massoud and Shalaby (1998) showed that irrigating sugar beet every 15, 30 or 45 days had no significant effect on sugar yield. EL-ASkari *et al*. (2003) mentioned that the water amount of 90% field capacity is highly recommended for sugar beet irrigation, since it gave high crop yield and acceptable yield quality. Ucan and Gencoglan (2004) pointed out that reduction in applied water reduced ET and root yield. Water applied 363 mm gave sugar rate of 18.6 %, sugar yield of 1935 kg/ha and root yield of 10420 kg/ha.

With respect to the crop water relations, Doorenbos *et al.* (1979) reported that water requirements ranged from 55 to 75 cm. The crop coefficient (Kc) is 0.4-0.5, 0.7-0.85, 1.05-1.20, 0.9-1.0 and 0.6-0.7 during the initial, crop development, mid –season, late season and at harvesting stages, respectively. The water use efficiency (WUE) is 6 - 9 kg roots/m^3. Water consumed. Prasad *et al.* (1985) indicated that the maximum consumptive use (65 cm) was observed at 80% ASM, whereas WUE was higher under more ASM and increasing N fertilization. Semaika *et al*. (1988) revealed that ET values decreased as ASMD increased. Crop coefficient values proved that they mainly depend on ASMD level in the root zone, besides the crop characters. The highest Kc values were detected from irrigation at 20% ASMD. Ibrahim (1990) found that irrigating sugar beet at 30, 60 and 90%

ASMD resulted in water consumptive use (ETc) of 2699.5, 2271.8 and 2127.7 m^3/fed., respectively. The highest WUE (6.3kg/m^3 water consumed) was resulted from irrigation at 30% ASMD. Massoud and Shalaby (1998) showed that sugar beet consumptive use were 6028, 5107 and 3449 m^3/ha for irrigation at 15, 30 and 45 days, respectively. Increasing irrigation interval increased WUE. EL-Askari *et al*. (2003) indicated that irrigation with water amount equal to 90 % of field capacity gave good WUE values. EL-Shouny *et al.* (2003) concluded that ETc values were 75.08, 73.29 and 70.58 cm for irrigation at 40, 60 and 80% ASMD, respectively. Irrigation at 60 % ASMD gave the highest WUE.

MATERIALS AND METHODS

Two field experiments were conducted at Fayoum Governorate during 2004/2005 and 2005/2006 seasons to study the effect of salinity and drought on sugar beet crop and its quality, i.e. yield components, fresh root yield, yield quality and some crop water relations. To achieve these objectives, soil samples were taken from many sites at Tameia destrict to determine the soil salinity values and these sites were chosen to carry out the experiment in the 1^{st} and 2^{nd} seasons. Three soil salinity levels, i.e. S_1: 4.0, S_2:9.8 and S_3: 13.5 dS/m were combined with three irrigation regimes treatments, i.e. irrigation at I_1: 35%, I_2: 55%, I_3: 75% from available soil moisture depletion (ASMD) in a split –plot design with four replications. The sub-plot area was 42m^2 (6.0 m length x 7.0 m width), which contained 12 ridges. Each sub- plot was isolated from the other plots by diskes of 1.2 m width to avoid the horizontal water seepage.

Sugar beet seeds (Gloria cv.) at the rate of 5.0 kg seeds/ feddan was planted on October 5^{th} and 15^{th} in the first and second season, respectively, in hills of 15.0 cm apart and thinned for one plant/hill before the first irrigation. Nitrogen fertilization (ammonium nitrate 33.5 % N) at the rate of 80 kg N/feddan was added in two equal doses (at the 1^{st} and 2^{nd} irrigations). Calcium super phosphate (15.5 P_2O_5) at the rate of 200 kg /feddan and potassium sulphate (48.0 % K_2O) at the rate of 50 kg/feddan were applied during field preparation. Harvesting was conducted on May 10^{th} and 5^{th} in first and second seasons, respectively.

The soil physical and chemical properties of the experimental plots were determined according to Klute (1986) and Page *et al.* (1982) and presented in Table(1). The monthly averages of climatic factors for Fayoum Governorate during the two growing seasons are shown in Table (2). Application of irrigation regime treatments started from the second irrigation. The soil moisture constants of the experimental field (mean of the two seasons) are listed in Table (3), whereas dates of irrigation and irrigation intervals for different treatments in 2004/2005 and 2005/2006 seasons are recorded in Table (4).The soil moisture values were gravimetrically determined on oven dry basis, as the technique of Water Requirements and Field Irrigation Dept., A.R.C., Egypt for different soil layers, each of 15.0 cm from soil surface and down to 60 cm depth. At harvesting time the following data were recorded for each sub- plot.

Table (1): Physical and chemical analysis of the experimental field during 2004/2005 and 2005/2006 seasons (average of two seasons).

A. Physical analysis:

Soil Type	Sand %	Silt %	Clay %	Texture classes	Organic matter %	CaCo3%
4.00 (S_1)	39.00	21.16	39.78	Clay loam	1.72	5.16
9.80 (S_2)	54.21	11.71	34.07	Sand clay loam	0.90	5.90
13.50 (S_3)	46.72	15.13	33.14	Clay loam	1.19	6.21

B. Chemical analysis :

ECe dS/m	pH 1:2.5 Extract	Soluble cation meq/1L				Soluble anions meq/1L				CEC meq/100 gm soil	Exchangeable cations meq/100gm soil			
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Cl^{-}	$HCo3^{-}$	Co3	So4		Ca^{++}	Mg^{++}	Na^{+}	K^{+}
4.00	8.10	8.18	7.69	24.67	0.33	20.73	3.06	-	17.08	32.47	16.29	10.74	4.05	1.12
9.80	8.20	18.73	9.27	68.05	0.51	41.14	3.04	-	52.38	21.78	10.14	7.50	3.14	0.76
13.50	8.32	22.24	15.30	110.34	1.01	84.2	3.91	-	60.77	25.70	13.19	8.25	3.19	0.82

Table (2): The monthly averages of climatic factors for Fayoum Governorate during 2004/2005and 2005/2006 seasons.

Month / seasons	Temperature (◦c)			Relative humidity (%)	Wind speed (m/sec)	Solar radiation (mm/day) **	Class A Pan evaporation (mm/day) *
	Max.	Min.	Mean				
October/2004	31.8	18.0	24.9	54	2.8	6.88	4.60
2005	29.9	16.7	23.3	55	1.2	7.02	4.20
November/2004	27.7	13.7	20.7	55	3.2	5.65	3.20
2005	24.7	11.0	17.8	57	1.3	6.33	2.40
December/2004	21.6	8.10	14.8	59	2.4	4.58	1.80
2005	21.9	8.9	15.4	59	1.7	5.38	1.70
January/2005	21.1	7.6	14.2	56	2.1	5.17	2.00
2006	19.4	6.6	13.0	58	1.6	5.66	1.50
February/2005	21.0	6.9	13.9	55	3.0	6.42	2.60
2006	22.2	8.4	15.3	54	1.9	7.22	2.40
March/2005	25.2	9.4	17.3	53	3.2	8.13	4.00
2006	26.3	9.7	18.0	52	1.7	9.60	3.80
April/2005	30.4	13.0	21.7	51	3.0	10.14	5.30
2006	30.4	13.3	21.8	50	2.0	11.30	5.0
May/2005	31.4	15.9	23.6	48	2.2	10.37	6.04
2006	33.4	16.9	25.2	50	2.1	12.06	7.6

*** After Fayoum meteorological station (Etsa destrict)**
**** Calculated by Sammani (2002) equation.**

Table (3): The average values of soil moisture constants for the experimental field during 2004/2005 and 2005/2006 seasons (average of the two seasons).

Soil Salinity levels (dS/m)	Soil depth (cm)	Field capacity (%)	Wilting point (%)	Soil bulk density (g/cm3)	Available soil moisture (%)
4.0 (S_1)	0-15	43.44	21.60	1.43	21.84
	15-30	41.77	19.91	1.46	21.86
	30-45	37.32	18.68	1.33	18.64
	45-60	32.66	17.24	1.40	15.42
9.8(S_2)	0-15	42.46	22.15	1.30	20.31
	15-30	36.86	19.07	1.40	17.79
	30-45	36.94	18.92	1.46	18.02
	45-60	32.70	17.22	1.48	15.48
13.5 (S_3)	0-15	41.96	21.34	1.38	20.62
	15-30	38.52	19.75	1.48	18.77
	30-45	39.34	20.15	1.42	19.19
	45-60	34.98	18.22	1.39	16.76

T4

I. Yield and Yield components:

Ten guarded plants were randomly chosen from the middle ridge of each sub- plot to determine the following data:

1- Root length (cm) 2- Root diameter (cm). 3-Root weight(kg).
4- The whole plant weight (kg) 5- Fresh root yield /fed. (ton): determined from the root yield of the whole sub-plot.

II. Crop quality.

1. Sucrose percentage: was determined by Sucrometer and using lead acetate according to the methods of **A.O.A.C.(1965)** .
2. Total soluble salts (T.S.S): was determined by the Refractometer.
3. Juice purity percentage: was calculated as follows:
   Juice purity % = {(Sucrose %)/ (T.S.S %) x 100}
4. Sugar yield (t/ fed.): was calculated from the sucrose percentage and the fresh root yield of the same treatment.

All the measurements and data collected were subjected to the statistical analysis according to the methods described by Snedecor and Cochran (1980).

III. Crop water relations:

1. **Seasonal consumptive use (ETc)**

For obtaining the crop water consumptive use (ETc), soil samples were taken just before and 48 hours after each irrigation, as well as at harvest time. The crop water consumptive use between each two successive irrigations was calculated according to the following equation (Israelsen and Hansen, 1962).

$$Cu\ (ETc) = [(Q_2 - Q_1)/100] \times Bd \times D$$

Where: Cu = crop water consumptive use (cm)
Q_2= soil moisture percentage 48 hours after irrigation.
Q_1= soil moisture just before irrigation.
Bd = soil bulk density (gm/cm^3).
D= soil layer depth (cm).

2. **Daily ETc rate (mm/ day).** Calculated from the ETc between each two successive irrigations divided by the number of days.
3. **Reference evapotranspiration (ET0)**
   Estimated as a monthly rate (mm/day), using the monthly averages of climatic factors of Fayoum Governorate and the procedures of the FAO-penman. Monteith equation (Allen *et al*. 1998).

4- Crop Coefficient (Kc).

The crop coefficient was calculated as follows:

$$Kc = ETc / ET0$$

Where: ETc = Actual crop evapotranspiration and ET0 = Reference evapotranspiration.

5- Water use efficiency (WUE).

The water use efficiency as kg roots/m^3 water consumed was calculated for different treatments as the method described by Vites (1965):

WUE ={Grain yield (kg/fed.) / Seasonal crop consumptive use "Cu"(m^3/fed.)}

RESULTS AND DISCUSSION

I. Yield and Yield components

1. Yield components.

The results presented in Table (5) reveal that sugar beet yield components, i.e. root length, root diameter ,root weight, whole plant weight were significantly affected by soil salinity levels in both seasons. Planting sugar beet crop in soil of 4.0 dS/m gave the highest averages of yield components in both seasons. Increasing soil salinity from 4.0 to 9.8 dS/m significantly decreased root length, root diameter, root weight and whole plant weight in 2004/2005 season by 12.2, 13.0, 18.0 and 20.4%, and in 2005/2006 season by 20.8, 13.6, 39.1 and 34.6%, respectively. However, more increase in soil salinity from 4.0 to 13.5 dS/m significantly decreased root length, diameter, root weight and plant weight in 2004/2005 season by 16.4, 23.8, 29.9 and 32.8% , and in 2005/2006 season by 25.6, 21.3, 55.3 and 46.1%, respectively. It is obvious that increasing soil salinity level significantly decreased sugar beet yield components. These results may be referred to the effect of high salinity level on water and nutrients absorption by the roots and this in turn reduced root cell division and decreased dry matter accumulation in the plant organs. These results are in the same line with those reported by Lindhauer *et al.* (1990), EL-Samnoudi and Abou- Arab (1997), Kamel (1999).

Regarding the effect of irrigation regimes, the data recorded in Table (5) indicate that the averages of sugar beet yield components were significantly varied due to irrigation regime treatments in both seasons. Increasing the available soil moisture depletion from 35 to 55% significantly decreased root diameter, root weight and whole plant weight in the first season by 14.6, 15.9 and 12.0%, and in the second season by 9.9, 22.2 and 15.5, respectively, whereas the root length was significantly increased by 5.4 and 4.0% in 2004/2005 and 2005/2006 seasons, respectively. More increase in the soil moisture depletion from irrigation at 35 to 75% ASMD caused considerable decreases in root diameter, root weight and whole plant weight, reached in 2004/2005 season to 17.5, 30.1 and 30.2%, and in 2005/2006 season to 17.4, 34.2 and 24.7%, respectively. On the other hand, the same increase in ASMD led to significant increase in root length by 13.1% and 12.5 % in the two successive seasons. It is evident that increasing the ASMD resulted in significant reductions in yield components of sugar beet, unless root length. These results may be attributed to the effect of soil moisture stress in the root zone on reducing water and nutrients absorption by roots and this in turn reduced photosynthesis, cell division and dry matter accumulation in storage organs, whereas drought may encourage the primary root to down elongation researching for moisture in far depth. Such findings are in harmony with those reported by Brown *et al.* (1987) and Khafagi and EL-Lawendy (1997).

The obtained results in Table (5) show that the interaction between soil salinity levels and irrigation regime treatments had significant effects on sugar beet yield components in both seasons except root length and root diameter in 2004/2005 season. Planting sugar beet in soil of 4.0 dS/m level and irrigation at 35% ASMD (frequent irrigation) gave the highest averages of root diameter, root weight and whole plant weight in 2004/2005 and 2005/2006 seasons. However, the highest root length was resulted from 4.0dS/m level and irrigation at 75% ASMD in both seasons. The lowest averages of root diameter, root weight and whole plant weight were detected from soil of salinity level 13.5 dS/m and irrigation at 75% ASMD in both seasons.

2. Fresh root yield/fed.

The results presented in Table (5) revealed that soil salinity levels had significant effects on the averages of fresh root yield/fed. in the two seasons. Increasing soil salinity level from 4.0 to 9.8 or 13.5dS/m resulted in significant decreased in root yield/ fed. equal to 9.9 and 38.9%, respectively, in 2004/2005 season and 20.6 and 44.2%, respectively, in 2005/2006 season. It could be concluded that planting sugar beet in soil had salinity over 4.0 dS/m lead to significant reduction in the fresh root yield/ fed. These results were found to be true, since increasing salinity level of soil caused significant decreases in root length, root diameter and weight and whole plant dry weight. These results are in agreement with those reported by Doorenbos *et al*. (1979), Lindhouer *et al* . (1990), EL-Samnoudi and Abou-Arab (1997), Kamel (1999) and Mekki and EL-Gazzar (1999).

Table (5): Effect of soil salinity levels, irrigation regime treatments and their interaction on sugar beet root yield and yield components in 2004/2005 and 200/2006 seasons.

Treatments		2004/ 2005					2005 / 2006				
Soil salinity levels	Irrigation regime treatments (ASMD)	Root length (cm)	Root diameter (cm)	Root weight (kg)	Plant weight (kg)	Fresh root yield (t/fed.)	Root length (cm)	Root diameter (cm)	Root weight (kg)	Plant weight (kg)	Fresh root yield (t/fed.)
4.0 (S_1)	I_1:35%	18.00	10.50	2.00	2.75	23.50	21.12	10.87	3.12	3.62	26.00
dS/m	I_2:55%	19.20	9.15	1.70	2.55	20.47	22.75	10.37	2.62	3.25	23.87
	I_3:75%	20.75	9.15	1.23	1.75	16.45	24.50	9.87	2.25	2.75	21.75
Mean		19.32	9.60	1.64	2.35	20.14	22.79	10.37	2.66	3.21	23.87
9.8 (S2)	I_1:35%	16.20	9.80	1.70	2.35	21.70	17.12	10.25	2.12	2.56	20.62
dS/m	I_2:55%	16.50	7.75	1.25	1.80	17.50	17.62	8.62	1.50	2.00	19.37
	I_3:75%	18.20	7.50	1.08	1.45	15.25	19.37	8.00	1.25	1.75	16.87
Mean		16.97	8.35	1.34	1.87	18.15	18.04	8.96	1.62	2.10	18.95
13.5 (S_3)	I_1:35%	15.20	8.00	1.20	1.65	14.00	16.50	9.12	1.50	1.94	16.12
dS/m	I_2:55%	16.35	7.25	1.15	1.60	12.70	16.62	8.25	1.12	1.62	13.37
	I_3:75%	16.90	6.70	1.10	1.50	10.20	17.75	7.12	0.94	1.62	10.44
Mean		16.15	7.32	1.15	1.58	12.30	16.96	8.16	1.19	1.73	13.31
Mean of	I_1:35%	16.46	9.43	1.63	2.25	19.73	18.25	10.08	2.25	2.71	20.19
Irrigation	I_2:55 %	17.35	8.05	1.37	1.98	16.89	18.99	9.08	1.75	2.29	18.87
	I_3:75%	18.61	7.78	1.14	1.57	13.97	20.54	8.33	1.48	2.04	16.35
L.S.D at	S	00.55	00.62	00.21	00.11	2.60	1.25	0.67	0.30	0.33	1.08
5.0 %	I	0.50	00.54	00.15	00.15	2.29	0.68	0.30	0.17	0.16	0.50
	(S) x (I)	N.S	N.S	0.26	0.2	N.S	1.17	0.52	0.30	0.28	0.86

The recorded data in Table (5) show that irrigation regime treatments significantly affected the averages of root yield/fed. in both season. The highest fresh root yield/fed., i.e. 19.73 and 20.19 t/fed. in 2004/2005 and 2005/2006 seasons, respectively, were detected from irrigating sugar beet plants at 35% ASMD (frequent irrigations). Increasing the ASMD from 35 to

55 or 75% result in significant decreases in root yield/fed. which reached in 2004/2005season to 14.4 and 29.2% and in 2005/2006 season to 6.5 and 19.0%, respectively. It could be revealed that irrigating sugar beet plants at high ASMD (long intervals) significantly decreased root yield/fed. These results may referred to the decrease in yield components resulted from irrigation at long intervals. The obtained results are in accordance with those reported by Brown *et al.* (1987), Semaika *et al.* (1988), EL-Askari *et al.* (2003) and Ucan and Gencoglan (2004).

II. Yield quality:

Data listed in Table (6) indicate that sugar beet yield quality parameters, i.e. sucrose percentage, total soluble solids (T.S.S) %, juice purity % and sugar yield/feddan were significantly affected by soil salinity levels in both seasons. Planting sugar beet in soil of 4.0 dS/m gave the highest averages of yield quality in the two seasons, whereas the lowest ones were detected from high soil salinity level (13.5 dS/m) in both seasons. Increasing soil salinity from 4.0 to 13.5 dS/m significantly decreased sucrose%, T.S.S%, juice purity% and sugar yield/feddan in 2004/2005 season by 14.5, 5.7, 1.1 and 47.4% and in 2005/2006 season by 10.8, 5.4, 6.1 and 50% , respectively. It could be concluded that increasing soil salinity significantly reduced yield quality parameters and sugar yield/feddan Such finding may be due to the high salinity effect on increasing the osmotic pressure of the soil solution and this in turn reduced water, nutrients and other minerals absorption, as well as decreasing photosynthesis and carbohydrate content in plants. The results are in the same line of those reported by EL-Samnoudi and Abou- Arab (1997) and Kamel (1999).

Table (6): Effect of soil salinity levels, irrigation regime treatments and their interaction on the averages of sugar beet yield quality in 2004/2005 and 2005/2006 seasons.

Treatments		2004/2005				2005/2006			
Soil salinity levels	Irrigation regime treatments (ASMD)	Sucrose (%)	T.S.S (%)	Juice purity (%)	Sugar yield (ton /fed.)	Sucrose (%)	T.S.S (%)	Juice purity (%)	Sugar yield (ton/fed.)
4.0 (S_1) dS/m	I_1:35%	20.33	20.25	95.49	4.77	19.47	20.37	95.30	5.06
	I_2:55%	19.62	20.19	94.76	4.01	19.63	20.04	98.16	4.68
	I_3:75%	19.22	21.16	95.73	3.16	19.45	21.21	91.71	4.23
Mean		19.72	20.53	95.32	3.98	19.52	20.54	95.06	4.66
9.8 (S2) dS/m	I_1:35%	19.92	19.25	95.54	4.32	19.04	19.85	97.25	3.92
	I_2:55%	17.02	19.61	95.42	2.97	19.32	20.22	95.58	3.74
	I_3:75%	16.60	21.62	93.91	2.52	18.71	21.57	87.90	3.15
Mean		17.85	20.16	94.95	3.27	19.32	20.46	93.58	3.60
13.5 (S_3) dS/m	I_1:35%	18.50	18.63	93.92	2.58	18.10	18.37	95.37	2.92
	I_2:55%	16.16	19.83	94.46	2.05	18.00	19.81	90.88	2.41
	I_3:75%	15.94	19.62	94.35	1.62	16.14	19.77	81.65	1.68
Mean		16.86	19.36	94.24	2.08	17.41	19.44	89.30	2.33
Mean of Irrigation	I_1:35%	19.58	19.38	94.98	3.89	18.87	19.56	95.97	3.97
	I_2:55%	17.60	19.88	94.88	3.01	18.98	20.02	94.87	3.61
	I_3:75%	17.25	20.80	94.66	2.53	18.10	20.85	87.08	3.02
L.S.D at 5.0 %	S	0.61	0.56	0.30	0.44	0.34	0.56	2.93	0.25
	I	0.45	0.46	N.S	0.47	0.33	0.38	1.89	0.13
	(S) x (I)	0.78	0.79	00.79	N.S	0.58	0.66	3.26	0.23

The obtained results in Table (6) show that the averages of sucrose, T.S.S, juice purity percentages and sugar yield/feddan were differed significantly due to irrigation regime treatments in both seasons, except juice purity percentage in 2004/2005 season. Increasing ASMD from 35 to 75% significantly decreased sucrose, juice purity percentages and sugar yield/ feddan, whereas the T.S.S percentage was increased. These results were found to be true in the two seasons. It is obvious that sugar yield, obtained from irrigation at 35% ASMD (3.89 and 3.97 t/feddan in 2004/2005 and 2005/2006 seasons, respectively) surpassed those resulted from irrigation at 55 and 75% ASMD in 2004/2005 season by 29.23 and 53.75 % and in 2005/2006 season by 9.97 and 31.46%, respectively. These results may be referred to the effect of soil moisture deficit on decreasing plant growth, fresh root yield and carbohydrate concentration in roots. Such finding is agreeing those found by Prasad *et al*. (1985), Khafagi and EL-Lawendy (1997), EL-Askri *et al*. (2003) and Ucan and Gencoglan (2004).

The results of Table (6) reveal that the averages of sucrose, T.S.S, juice purity percentages and sugar yield/fed. were significantly affected by the interaction between soil salinity levels and irrigation regimes in both seasons, except sugar yield/fed. in 2004/2005 season. Planting sugar beet in soil of 4.0dS/m salinity and irrigated at 35% ASMD gave the highest sucrose percentages, i.e. 20.33 and 19.47 % and sugar yield, i.e. 4.77 and 5.06 t/feddan in 2004/2005 and 2005/2006 seasons, respectively. The lowest ones were detected from high salinity level (13.5 dS/m) and irrigation at 75% ASMD in both seasons. On the other hand, T.S.S % and Juice purity % varied from treatment to the other without constant trend.

III. Crop water relations.

1. Seasonal consumptive use (ETc).

The results in Table (7) indicate that the values of seasonal consumptive use of sugar beet crop, as a function of different treatments applied were 58.53 and 59.75 cm in 2004/2005 and 2005/2006 seasons, respectively. Increasing soil salinity level from 4.0 to 9.8 or 13.5 dS/m decreased seasonal ETc in 2004/2005 season from 61.82 cm to 58.23 and 55.55 cm and in 2005/2006 season from 62.67 cm to 59.0 and 57.59 cm, respectively. It is evident that increasing soil salinity decreased the seasonal ETc. These results may be due to that increasing salinity level led to raising the osmotic pressure of the soil solution in the root zone and this in turn reduce water absorption by roots causing transpiration reduction, less soil evaporation, less vegetative growth and low water consumption. The results are in the same order of that reported by Doorenbos *et al* (1979). Data recorded in Table (7) show that increasing ASMD from 35 to 55 or 75% reduced seasonal ETc of sugar beet in 2004/2005 season by 4.85 and 9.34 % and in 2005/2006 season by 5.0 and 10.23 %, respectively. It could be concluded that irrigating sugar beet plants at 35% ASMD (frequent irrigation) gave the highest seasonal ETc, i.e. 61.44 and 62.95 in the two successive seasons. These results are in accordance with those found by Doorenbose *et al*. (1979), Prasad *et al*. (1985), Semaika *et al*. (1988), Ibrahim (1990) and Massoud and Shalaby (1998).

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The obtained results in Table (7) reveal that planting sugar beet in soil of 4.0 dS/m salinity and irrigation at 35% ASMD gave the highest values of ETc. i.e. 65.19 and 66.65 cm in 2004/2005 and 2005/2006 seasons, respectively. However, the lowest ones, i.e. 52.36 and 54.45 cm were detected from salinity level of 13.5 dS/m and irrigation at 75% ASMD in the two successive seasons.

2. Daily ETc rate (mm/day).

Data listed in Table (7) generally show the daily ETc rates (over all mean) started with low values during October and November, then increased during December and January to reach its maximum values during March and declined during April and May such finding are referred to that at the germination and seedling stages most of water losses are caused by evaporation from the bare soil (Oct. and Nov). Thereafter, as the crop cover increased, transpiration from plants took place beside evaporation to reach the peak during rapid increase in root size and storage stage. During April the ETc rate decreased when leaves dried to reach its minimum values at harvesting. Results in Table (7) indicate that increasing soil salinity level led to decrease in daily ETc rate during the months of the sugar beet growing season duration, in both seasons. The highest daily ETc rates during the crop growing season months were resulted from low soil salinity level (4.0 dS/m) in the two seasons.

Data listed in Table (7) show that irrigating sugar beet plants at 35% ASMD (frequent irrigation) gave the highest ETc rates in all months of the growing season duration in 2004/2005 and 2005/2006, whereas irrigation at 75% ASMD resulted in the lowest ETc daily rates from October to May in both seasons. It could be concluded that irrigating sugar beet plants at short intervals (frequent irrigation) increased the daily ETc rate throughout the crop growing season months.

3. Reference evapotranspiration (ET0).

Reference ET or ET0 daily rates (mm/day), estimated using the FAO Penman-Montheith equation and the meteorological data of Fayoum Governorate in 2004/2005 and 2005/2006 seasons from planting until harvesting are presented in Table (8). The obtained results revealed that the daily ET0 rate values were high during October, and then decreased during November and December months. There after the daily ET0 rate started in increasing from January and up to May in both seasons. These results mainly referred to the changes occurred in climatic factors from month to anther. In this connection, Allen *et al*. (1998) reported that the ET0 values depended mainly on the evaporative power of the air (temperature, radiation, wind speed and relative humidity).

4. Crop coefficient (Kc)

The Kc values were estimated from the daily ETc rate of sugar beet (Table 7) and the daily ET0 rate (mm/day), presented in Table (8), for the growing season duration months from October to May in 2004/2005 and 2005/2006 seasons. Results in Table (8) show that the Kc values of sugar

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beet, as affected by different applied treatment (over all mean) were low in the initial growth period (Oct. and Nov), then increased during December, January and February, as the plant vegetation increased. The Kc values reached its maximum values in March, as the period of maximum growth and maximum storage in roots, there after the values redecreased again, when plants started maturity to reach the minimum values at harvesting (May). These results may be due to the large diffusive resistance of bare soil at the initial growth period, which decreased with increasing the crop cover percentage until maximum growth and root storage. However, at maturity the transpiration decreased, as the during of most leaves.

Data in Table (8) indicate that increasing soil salinity level from 4.0 to 9. 8 or 13.5 dS/m decreased the Kc values during the growing season months in both seasons. Soil salinity level of 4.0 dS/m gave the highest Kc values during the growing season months of the two seasons, whereas the lowest Kc values were detected from soil salinity level of 13.5 dS/m in both seasons. On the other hand, increasing ASMD in the root zone of sugar beet plant to 55 or 75% decreased the Kc values in all months of the growing season duration in 2004/2005 and 2005/2006 seasons. The highest Kc values were resulted from irrigating plants at 35% ASMD, whereas the lowest ones were obtained from irrigation at 75% ASMD, in both seasons. These results are in the same trend of those reported by Doorenbos *et al.* (1979) and Semaika *et al*. (1988). The Kc values of sugar beet for high fresh root yield and sugar yield are 0.52, 0.71, 0.88, 1.14, 1.28, 1.08, 0.69 and 0.55 for Oct., Nov., Dec., Jan., Feb., March .Ap. and May month, respectively, (average of the two seasons).

5. Water use efficiency (WUE).

The obtained results in Table (9) indicate that the mean values of WUE, as a function of soil salinity levels and irrigation regimes were .6.79 and 7.39 kg roots/m^3 water consumed in first and second seasons, respectively. Planting sugar beet in soils of 4.0 dS/m salinity gave the highest averages of WUE, i.e.7.72 and 9.06 kg fresh roots/m^3 water consumed in the two successive seasons. However, the lowest WUE values, i.e. 5.25 and 5.47 kg fresh roots /m^3 water in 2004/2005 and 2005/2006 seasons, respectively, were detected from planting the crop in soil of 13.5 dS/m salinity. It is obvious that increasing soil salinity level decrease WUE by sugar beet plants. Data listed in Table (9) show that irrigation at 35% ASMD gave the highest WUE values, i.e. 7.60 and 7.86 kg roots/m^3 water consumed in 2004/2005 and 2005/2006 seasons, respectively. Irrigation at 55 or 75 ASMD decreased the WUE values in 2004/2005 season by 10.0 and 21.97 % and in 2005/2006 season by 4.96 and 13.1 %, respectively. It could be noticed that increasing ASMD to high levels decreased the WUE of sugar beet crop. Such findings are in harmony with those reported by Doorenbos *et al.,* (1979), Prasad *et al*. (1985) and Ibrahim (1990).

Table (9): Effect of soil salinity levels, irrigation regime treatments and their interaction on water use efficiency (kg fresh roots/m^3 water consumed in 2004/2005 and 2005/2006 seasons.

Soil salinity levels (dS/m)	2004/2005				2005/2006			
	Irrigation regime treatments				Irrigation regime treatments			
	(I_1) 35% ASMD	(I_2) 55% ASMD	(I_3) 75% ASMD	Mean	(I_1) 35% ASMD	(I_2) 55% ASMD	(I_3) 75% ASMD	Mean
4.0 (S_1)	8.58	7.97	6.62	7.72	9.28	9.14	8.75	9.06
9.8 (S_2)	8.53	7.12	6.53	7.39	7.94	7.78	7.18	7.64
13.5 (S_3)	5.69	5.42	4.64	5.25	6.36	5.49	4.56	5.47
Mean	7.60	6.84	5.93	6.79	7.86	7.47	6.83	7.39

Results in Table (9) reveal that planting sugar beet in soil of salinity level, 4.0 dS/m and irrigation at 35% ASMD gave the highest WUE values, i.e. 8.58 and 9.28 kg fresh roots/m^3 water consumed in 2004/2005 and 2005/2006 seasons, respectively. However, planting in soil of high salinity level (13.5 dS/m) and irrigation at 75 ASMD (long intervals) gave lowest WUE values, i.e. 4.64 and 4.56 kg roots /m^3 water consumed in the two successive seasons. It could be concluded that for high WUE by sugar beet crop the salinity level of soil should be not more than 4.0dS/m and irrigation should applied at 35% ASMD .

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إستجابة محصول بنجر السكر والجوده والعلاقات المائيه لظروف ملوحة التربة والجفاف

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أقيمت تجربتان حقليتان بمركز طامية – محافظة الفيوم – مصر خلال موسمى الزراعة 2005/2004 , 2006/2005 لدراسة تأثير مستويات ملوحة التربة والجفاف على محصول بنجر السكر ومكوناته وجودة المحصول وبعض العلاقات المائيه للمحصول. ولتحقيق هذه الأهداف تم دراسة ثلاث مستويات لملوحة التربة (ملليموز/سم) وهى 4(S_1) ، 9.8(S_2) ، 13.5 (S_3) مع ثلاث معاملات ري هى: (I_1):الرى عند فقد 35% ، (I_2):55% ، (I_3) 75% من ماء التربه الميسر وذلك فى تصميم القطع المنشقه مره واحده فى 4 مكررات وكانت أهم النتائج المتحصل عليها ما يلى :

1- تأثر طول الجذر ، قطر الجذر ، وزن الجذر ، وزن النبات الكلى ومحصول الجذور للفدان تأثرا معنويا بمستويات ملوحة التربة ومعاملات الرى فى كلا الموسمين.

2- أعطى مستوى الملوحة 4 ملليموز/سم والرى عند فقد 35% من الماء الميسر أعلى متوسطات لقطر الجذر ، وزن الجذر ، وزن النبات الكلى ، ومحصول الجذور/ف (23.5 ، 26.0 طن/ف فى 2005/2004 ، 2006/2005على الترتيب). بينما نتجت أقل المتوسطات من مستوى ملوحة التربة العالى (13.5 ملليموز/سم) والرى عند فقد 75% من الماء الميسر فى كلا الموسمين.

3- زيادة ملوحة التربة عن 4 ملليموز/سم أو زيادة فقد الماء الميسر من 35% إلى 55% أو 75% أدى إلى نقص معنوى فى محصول الجذور ومكوناته فى كلا الموسمين ، عدا طول الجذر.

4- نتج أعلى نسبة مئوية للسكر بالجذور (20.33 ، 19.47%) وأعلى كمية لمحصول السكر (4.77 ، 5.06 طن/ف)من مستوى الملوحة 4 ملليموز/سم والرى عند فقد 35% من ماء التربة الميسر وذلك فى موسمى 2005/2004 ، 2006/2005 على الترتيب.

5- كان متوسط الإستهلاك المائى لبنجر السكر هو 58.53 ، 59.75 سم فى 2005/2004 ، 2006/2005 على الترتيب. وزيادة ملوحة التربة من 4 إلى 13.5 ملليموز/سم وزيادة فقد الماء الميسر من 35% إلى 75% أدى إلى نقص الأستهلاك المائى للمحصول من 61.82 ، 61.44 سم إلى 55.55 ، 55.70 سم فى كلا الموسمين المتعاقبين.

6- معدل الأستهلاك المائى اليومى للمحصول بدأ بقيم منخفضة وزاد تدريجيا خلال ديسمبر، ويناير ليصل إلى أقصى قيمة له خلال مارس ثم انخفض مره أخرى فى أبريل ومايو. وكانت قيم ثابت المحصول (Kc) خلال أشهر نمو المحصول من اكتوبر وحتى مايو هى 0.52، 0.71 ، 0.88 ، 1.14 ، 1.28 ، 1.08 ، 0.69 ، 0.55 على الترتيب (متوسط الموسمين).

7- نتجت أعلى كفاءة لأستهلاك الماء (8.58 ، 9.28 كجم جذور/م3 ماء مستهلك فى الموسمين المتعاقبين) من مستوى ملوحة التربة 4 ملليموز/سم والرى عند فقد 35% من ماء التربة الميسر.

Table (4): Irrigation number, irrigation dates and intervals (day) for sugar beet crop, as affected by soil salinity levels, and irrigation regimes in 2004/2005 and 2005/2006 seasons.

Number of Irrigation	Soil salinity levels (S1) 4.0 dS/m.						(S2) 9.8 dS/m.						(S3) 13.5 dS/m.					
	Irrigation regimes (ASMD)**						Irrigation regimes (ASMD)						Irrigation regimes (ASMD)					
	(I_1) 35%		(I_2) 55%		(I_3) 75%		(I_1)35%		(I_2) 55%		(I3) 75%		(I_1) 35%		(I_2) 55%		(I_3) 75%	
	Date	Interval (days)	Date	Interval (days)	Date	Interval (days)	Date	Interval (days)	Date	Interval (days)	Date	Interval (days)	Date	Interval (days)	Date	Interval (days)	Date	Interval (days)
2004 / 2005																		
Planting	5/10	-	5/10	-	5/10	-	5/10	-	5/10	-	5/10	-	5/10	-	5/10	-	5/11	-
1st.irr. *	1/11	27	1/11	27	1/11	27	1/11	27	1/11	27	1/11	27	1/11	27	1/11	27	1/11	27
2nd.irr.	22/11	21	25/11	24	29/11	28	22/11	21	22/11	21	24/11	23	20/11	19	21/11	20	22/11	21
3rd.irr.	9/12	17	16/12	21	26/12	27	6/12	14	10/12	18	17/12	23	4/12	14	10/12	19	14/12	22
4th.irr.	24/12	15	6/1	21	20/1	25	19/12	13	27/12	17	8/1	22	17/12	13	30/12	20	2/1	19
5thirr.	6/1	13	24/1	1	15/2	26	1/1	13	13/1	17	1/2	24	30/12	13	18/1	19	21/1	19
6th irr.	25/1	19	15/2	22	15/3	28	18/1	17	2/2	20	24/2	23	14/1	15	8/2	21	10/2	20
7th irr.	18/2	24	15/3	28	8/4	24	7/2	20	24/2	22	17/3	21	2/2	19	2/3	22	11/3	29
8th irr.	15/3	25	8/4	24	-	-	28/2	21	16/3	20	8/4	22	24/2	22	23/3	21	8/4	28
9th irr.	8/4	24	-	-	-	-	21/3	21	8/4	23	-	-	19/3	23	8/4	16	-	-
10th irr.	-	-	-	-	-	-	8/4	18	-	-	-	-	8/4	20	-	-	-	-
Harvest	10/5	32	10/5	32	10/5	32	10/5	32	10/5	32	10/5	32	10/5	32	10/5	32	10/5	32
Count	10		9		8		11		10		9		11		10		9	
2005 / 2006																		
Planting	15/10	---	15/10	---	15/10	---	15/10	---	15/10	---	15/10	---	15/10	---	15/10	---	15/10	---
1st.irr. *	3/11	19	3/11	19	3/11	19	3/11	19	3/11	19	3/11	19	3/11	19	3/11	19	3/11	19
2nd.irr.	25/11	22	29/11	26	10/12	37	22/11	19	25/11	22	3/12	30	17/11	14	21/11	18	29/11	26
3rd.irr.	18/12	23	27/12	28	8/1	29	7/12	15	14/12	19	25/12	22	30/11	13	8/12	17	15/12	16
4th.irr.	5/1	18	27/1	31	14/2	37	26/12	19	3/11	20	24/1	30	17/12	17	25/12	17	23/1	39
5thirr.	27/1	22	24/2	28	3/3	17	11/1	16	25/1	22	19/2	26	31/12	14	17/1	23	25/2	33
6th irr.	21/2	25	8/3	12	29/3	26	31/1	20	22/2	28	8/3	17	18/1	18	5/2	19	11/3	14
7th irr.	6/3	13	29/3	21	---	---	24/2	24	8/3	14	29/3	21	5/2	18	22/2	17	29/3	18
8th irr.	29/3	23	---	---	---	---	11/3	15	29/3	21	---	---	24/2	19	11/3	17	---	---
9th irr.	---	---	---	---	---	---	29/3	18	---	---	---	---	11/3	15	29/3	18	---	---
10th irr.	---	---	---	---	---	---	---	---	---	---	---	---	29/3	18	---	---	---	---
Harvest	5/5	38	5/5	38	5/5	38	5/5	38	5/5	38	5/5	38	5/5	38	5/5	38	5/5	38
count	9		8		7		10		9		8		11		10		8	

*** irr. = Irrigation** **** ASMD = available soil moisture depletion**

Table (7): Effect of soil salinity levels, irrigation regime treatments and their interaction on the averages of daily consumptive use (cm) and the daily consumptive use rate (mm/ day) of sugar beet crop in 2004/2005 and 2005/2006 seasons .

Treatments		2004 / 2005									2005 / 2006								
Soil salinity	Irrigation (ASMD)	Seasonal consumptive use (ETc) cm	Oct.	Nov.	Dec.	Jun.	Feb.	Mar	Ap.	May	Seasonal consumptive use (ETc) cm	Oct.	Nov	Dec.	Jun.	Feb.	Mar.	Ap.	May
(S_1) 4.0 dS/m	I_1:35%	65.19	2.25	2.08	2.05	2.97	4.10	4.10	3.32	3.14	66.65	2.02	2.15	2.08	2.71	4.56	4.75	4.11	4.11
	I_2:55 %	61.12	1.97	1.72	1.80	2.38	3.90	4.22	3.45	3.33	62.15	2.04	1..87	2.11	2.49	4.10	4.18	3.54	3.54
	I_3:75%	59.15	2.09	1.67	1.74	2.54	3.50	3.96	3.32	3.19	59.21	2.15	1.75	2.04	2.32	3.87	4.85	3.12	3.12
Mean		61.82	2.10	1.82	1.86	2.63	3.83	4.09	3.36	3.22	62.67	2.07	1.92	2.07	2.51	4.18	4.59	3.59	3.59
(S_2) 9.8 dS/m	I_1:35%	60.56	1.83	1.40	2.06	3.04	4.39	3.98	2.79	2.61	61.82	2.12	2.14	2.22	2.62	4.41	4.48	3.02	3.02
	I_2:55 %	58.53	1.76	1.72	2.11	2.61	3.63	4.01	2.92	2.63	59.31	2.09	2.02	2.14	2.62	4.14	4.56	3.63	2.65
	I_3:75%	55.60	1.73	1.76	1.80	2.17	2.98	4.15	3.09	2.85	55.87	2.07	1.98	2.05	2.29	3.73	4.32	2.61	2.61
Mean		58.23	1.77	1.63	1.99	2.61	3.67	4.05	2.93	2.70	59.00	2.09	2.05	2.14	2.51	4.09	4.45	2.72	2.76
(S_3) 13.5 dS/m	I_1:35%	58.56	1.71	1.76	2.06	3.02	4.12	3.50	2.74	2.64	60.39	2.05	2.14	2.16	2.67	4.22	4.78	2.54	2.54
	I_2:55%	55.74	1.71	1.77	1.92	2.34	3.28	3.96	2.85	2.63	57.94	2.09	1.97	2.04	2.32	4.14	4.66	2.54	2.54
	I_3:75%	52.36	1.70	1.73	1.80	2.18	3.40	3.35	2.62	2.46	54.45	2.03	1.98	1.98	2.31	3.37	4.60	2.35	2.35
Mean		55.55	1.71	1.75	1.93	2.51	3.60	3.60	2.74	2.58	57.59	2.06	2.03	2.06	2.43	3.91	4.68	2.48	2.48
Mean of irrigation																			
I_1:35%		61.44	1.93	1.75	2.06	3.01	4.20	3.86	2.95	2.80	62.95	2.06	2.14	2.15	2.66	4.40	4.67	3.22	3.22
I_2:55 %		58.46	1.81	1.74	1.94	2.44	3.60	4.06	3.07	2.86	59.80	2.07	1.95	2.09	2.48	4.13	4.46	2.90	2.91
I_3:75%		55.70	1.84	1.72	1.78	2.30	3.29	3.82	3.01	2.83	56.51	2.08	1.90	2.02	2.31	3.66	4.59	2.69	2.69
Overall mean		58.53	1.86	1.73	1.93	2.58	3.70	3.91	3.01	2.83	59.75	2.07	1.99	2.08	2.48	4.06	4.57	2.94	2.94

Table (8): Effect of soil salinity levels, irrigation regime treatments and their interaction on the averages of daily consumptive use (cm) and the daily consumptive use rate (mm/ day) of sugar beet crop in 2004/2005 and 2005/2006 seasons .

Treatments		2004 / 2005								2005 / 2006							
Soil salinity	**Irrigation (ASMD)**	**Oct.**	**Nov.**	**Dec.**	**Jun.**	**Feb.**	**Mar**	**Ap.**	**May**	**Oct.**	**Nov**	**Dec.**	**Jun.**	**Feb.**	**Mar.**	**Ap.**	**May**
References ET(ET0 mm/day)		4.27	2.97	2.17	2.58	3.34	3.71	4.62	6.16	4.2	2.98	2.75	2.42	3.40	4.52	6.10	7.02
(S_1) 4.0 dS/m	0.53	0.53	0.70	0.94	1.15	1.23	1.10	0.72	0.51	0.50	0.72	0.81	1.12	1.34	1.05	0.67	0.58
	0.46	0.46	0.58	0.83	0.92	1.17	1.14	0.75	0.54	0.51	0.63	0.82	1.03	1.21	0.92	0.58	0.50
	0.49	0.49	0.56	0.80	0.98	1.05	1.07	0.72	0.52	0.53	0.59	0.79	0.96	1.14	1.07	0.51	0.44
Mean		0.49	0.49	0.61	0.86	1.02	1.15	1.10	0.73	0.52	0.51	0.65	0.81	1.03	1.23	1.01	0.59
(S_2) 9.8 dS/m	0.43	0.43	0.47	0.95	1.18	1.31	1.07	0.60	0.42	0.53	0.72	0.86	1.08	1.30	0.99	0.49	0.43
	0.41	0.41	0.58	0.97	1.01	1.09	1.08	0.63	0.43	0.52	0.68	0.83	1.08	1.22	1.01	0.43	0.37
	0.40	0.40	0.59	0.83	0.84	0.89	1.04	0.67	0.46	0.50	0.66	0.80	0.95	1.10	0.96	0.43	0.33
Mean		0.41	0.41	0.55	0.92	1.01	1.01	1.06	0.63	0.44	0.52	0.68	0.83	1.04	1.21	0.99	0.45
(S_3) 13.5 dS/m	0.40	0.40	0.59	0.95	1.17	1.23	0.94	0.59	0.36	0.51	0.72	0.84	1.10	1.24	1.06	0.42	0.36
	0.40	0.40	0.60	0.88	0.91	0.98	1.07	0.62	0.43	0.52	0.66	0.79	0.96	1.22	1.03	0.42	0.36
	0.40	0.40	0.58	0.83	0.84	1.02	0.90	0.57	0.40	0.50	0.66	0.77	0.95	0.99	1.02	0.38	0.33
Mean		0.40	0.59	0.89	0.97	1.08	0.97	0.59	0.40	0.51	0.68	0.80	1.00	1.25	1.04	0.41	0.35
Mean of irrigation I_1:35%		0.45	0.59	0.95	1.17	1.26	1.04	0.64	0.43	0.51	0.72	0.84	1.10	1.29	1.03	0.53	0.46
I_2:55 %		0.42	0.59	0.89	0.95	1.08	1.10	0.67	0.47	0.52	0.66	0.81	1.02	1.22	0.99	0.48	0.41
I_3:75%		0.43	0.58	0.82	0.89	0.99	1.00	0.65	0.46	0.51	0.64	0.79	0.95	1.08	1.02	0.44	0.38
Overall mean		0.43	0.59	0.89	1.00	1.11	1.05	0.65	0.45	0.51	0.67	0.81	1.02	1.20	1.01	0.48	0.42

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