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SUGAR BEET YIELD AND QUALITY CHARACTERS AND WATER RELATIONS UNDER CONDITIONS OF SOIL MOISTURE STRESS AND N FERTILIZER LEVELS.

BY

Ashry, M.R.K.* and Ekram A. Megawer**

* Soil and water, Environment Res. Instit., A.R.C. Giza, Egypt.

** Agron. Dept., Fac. Agric., Fayoum Unvi.

ABSTRACT

Two field experiments were carried out at Fayoum Agric. Res., station (Kom Osheem) during 2004/2005 and 2005/2006 seasons. Four irrigation treatments, i.e. irrigation at 30% (I_1), 55% (I_2), 80 %(I_3) available soil moisture depletion (ASMD) and 65 mm cumulative pan evaporation (I_4) were combined with three N fertilization levels, i.e. 50 (N_1), 75(N_2) and 100(N_3) kg N/ fed in a split- plot design with four replications. The effect of these combination treatments on sugar beet yield, yield components and quality characters and crop water relations were studied .The main results were as follows:

1. Root diameter, root weight, total plant weight, root yield/fed, sucrose%, T.S.S%, juice purity% and sugar yield/fed were significantly affected by irrigation treatments and N levels in both seasons, whereas root length was not affected by differed treatments in the two seasons.
2. Increasing ASMD from 30% to 80% significantly decreased root diameter and weigh, total plant weight, root yield/fed, sucrose% and sugar yield/fed, whereas T.S.S% and juice purity increased .
3. Root yield/fed, yield components, sucrose% and sugar yield/fed, obtained from irrigation at 65mm cumulative pan evaporation (CPE) surpassed those of irrigation at 55% or 80% ASMD in both seasons.
4. Increasing N level from 50 to 75 kg N/fed increased yield components, root yield/fed, sucrose% and sugar yield, whereas T.S.S% and purity% decreased. However, more increase in N level to 100 kg N/fed significantly reduced all yield components, root yield/fed, sucrose% and sugar yield/fed, in both seasons.
5. The highest yield components, root yield (23.0 and 25.16 t/fed), sucrose% (23.52 and 22.81%) and sugar yield (5.41 and 5.73 t/fed) in 2004/2005 and 2005/2006 seasons, respectively, were resulted from irrigation at 30% ASMD and applying 75 kg N/fed. However, irrigation at 80% ASMD and applying 100 kg N/fed gave the lowest values in both seasons.
6. Seasonal consumptive use (ETc) averaged 64.09 and 62.41/cm in 2004/2005 and 2005/2006 seasons, respectively. Decreasing ASMD from 80% to 30% and increasing N level from 50 to 100 kg N/fed increased seasonal ETc from 57.71 and 56.86 cm to 68.65 and 66.03 cm in two successive seasons.

7. Daily ETc rate increased from Oct. and Nov., to reach its maximum rate during Mar., then declined till harvesting. The crop coefficient (Kc) during the growing season months from October to May were 0.59, 0.65, 0.84, 0.95, 1.09, 1.14, 0.81 and 0.55, respectively, (average of two seasons) from the treatment that gave the highest root and sugar yield/fed.
8. The highest water use efficiency values, i.e. 8.127 and 9.184 kg fresh root/m^3 water consumed, resulted from irrigation at 30% ASMD and applying 75 kg N/fed in 2004/2005 and 2005/2006 seasons, respectively.

So, the combination of 30% ASMD and 75 kg N/fed. could be recommended for sugar beet cultivation under the environmental conditions such as those described herein, where this treatment improved yield and quality characters combined with good water use efficiency.

Key words: Sugar beet, Yield, Quality, Water use, Fertilization.

INTRODUCTION

Irrigation and fertilization play an important role in sugar beet production. Increasing irrigation and fertilization use efficiency throughout agricultural treatments is a main objective for water and fertilizer rationalization to reduce environmental pollution and increasing sugar beet yield and quality. Doorenbos *et al.*, (1979) reported that water requirements of sugar beet crop ranged from 550 to 750 mm. The crop coefficients Kc were 0.4 -0.5, 0.7-0.85, 1.05-1.20, 0.9- 1.0 and 0.6-0.7 during the initial stage, development stage, mid-season, late season stage and harvesting, respectively. The water use efficiency (WUE) is 6.0 to 9.0 kg roots/ m^3 water consumed. Prasad *et al.*, (1985) indicated that a maximum consumptive use (ETc) of 58.9 cm was observed at 80 % available soil water depletion, which gave maximum sugar yield (6.3 t/ha). They added that higher rates of nitrogen fertilizer slightly increased ETc and WUE. Semaika *et al.*, (1988) revealed that the highest values of plant fresh and dry weights, as well as root length and diameter were obtained at 40% soil moisture depletion. The ETc values decreased as the available moisture depletion increased. Davidoff and Hanks (1989) pointed out that both yield and relative yield exhibited a strong linear relationship with ETc. Sucrose percentage tended to be increased as the amount of applied water increased. Ibrahim (1990) found that irrigation at 30, 60 and 90% available soil moisture depletion (ASMD) resulted in ETc of 2699.5, 2271.8 and 2127.7 m^3/ fed, respectively. The highest WUE was detected from irrigation at 30% ASMD. Massoud and Shalaby (1998) indicated that irrigation every 15, 30 or 45 days gave total water application of 10805, 7607 and 5766 m^3/ ha, while the total water consumed was 6028, 5107 and 3449 m^3/ha, respectively. Water use efficiency was increased as irrigation interval increased. El-Askari *et al.* (2003) concluded that the water irrigation amount of 90% field capacity is highly recommended for sugar beet irrigation since it gave a high crop yield, acceptable yield quality and good water use efficiency. El-Shouny *et al.* (2003) reported that irrigation at 40, 60 or 80% ASMD saved 28.65 %, 31.8% and 33.4% of water, respectively, compared to normal irrigation. The average values of ETc were 75.08, 73.29 and 73.58 cm for irrigation at 40, 60 and 80% ASMD, respectively. According to WUE values, irrigation treatments were orderly arranged as 60% > 40% > 80% ASMD > farmers irrigation for root and sugar yield.

Koren. Kov and Pirogova (1983) showed that applying the recommended rate of N (240 kg/ha, as ammonium nitrate) in two splits is preferable rather than as a single application. Prasad *et al.*, (1985) found that higher rates of N fertilizer slightly increased consumptive use. A significant increase in sugar yield was observed up to 180 kg N/ ha. EL-Badry (1988) indicated that average root, top and sugar yields were increased in the ranges of 3.8–18.2, 2.4-12.8 and 0.6-3.1 t/fed, respectively with increasing N rate from 30 to 60 kg N/fed. Shepherd (1991) indicated that sugar yield was declined with N applications above 150 kg/ha. Burcky (1993) concluded that water consumptive use increased with N supply. At the highest N rates water consumption was 3 times of the lowest N rate. Water use efficiency was highest with moderate N rate application. Barbanti *et al.* (1994) reported that the intermediate applications of 60 or 120 Kg N/ha proved to be the most effective N fertilizer application rate in terms of yield. Whereas, beet quality adversely affected by increasing N application in reduction to the increase in noxious elements and a decrease in juice alkalinity. Sharif and Eghbal (1994) found that root length, root diameter and root sugar yield were gradually with N application increased up to 150 kg N/ha. Contents of T.S.S and sucrose% and juice purity percentage were decreased with increasing N rates. Root yield was positively correlated with root length and diameter, L.A.I and leaf yield. Azzazy (1998) revealed that increasing nitrogen level from 40 to 60 or 80 kg N/fed increased root diameter and root yield, but decreased sucrose percentage. Ruzsangi (2000) pointed out that the application of 80-120 kgN/ ha, 80-100 kg P/ha and 120-160 kg K/ha are sufficient to reach large root yield and good industrial values. Karam *et al.* (2002) showed that yield was strongly dependent on level of N application where 260 units/ha of N fertilizer produced 223 and 169 t/ha at 100% and 60% field capacity irrigation, respectively. This mean that, water use efficiency seemed to be dependent on the N application rate under each irrigation regime. Bilbao *et al.* (2004) concluded that soil nitrate before planting could used as useful criteria for assessing N fertilizer rate in production of sugar beet under the Mediterranean climate. The critical value of soil nitrate above which no response to N fertilizer can be expected was 39 mg/kg for beet production.

MATERIAL AND METHODS

Field experiments were carried out at the farm of Kom Osheem research station, Fayoum Governorate, Egypt during 2004/2005 and 2005/2006 seasons. This study aimed to investigate the effect of irrigation using different levels of available soil moisture depletion (ASMD) and nitrogen fertilization rates (NFR) on sugar beet yield, yield components, quality characters and crop water relations. The experimental design used was the split–plot design with four replications. The experimental treatments were as follows:

I. Irrigation treatments (main plots).
I_1: irrigation at 30% available soil moisture depletion (ASMD).
I_2: irrigation at 55 % available soil moisture depletion (ASMD)
I_3: irrigation at 80 % available soil moisture depletion (ASMD)
I_4: irrigation at 65 mm cumulative pan evaporation (CPE).
II: Nitrogen fertilizer rates (sub- plots).
N_1: 50 Kg N/ fed, as ammonium nitrate 33.5% N.
N_2: 75 Kg N/ fed, as ammonium nitrate 33.5% N.
N_3: 100 Kg N/ fed, as ammonium nitrate 33.5% N.

The nitrogen fertilizer rates were applied in two equal doses (at the 1st and 2nd irrigations). The sub-plot area was 21.0 m^2 (3.0 x 7.0 m), contained six ridges of 50.0cm width and 7.0 m length. The sub-plot were isolated from each others by dikes of 1.5m to avoid the horizontal water seepage. Calcium super phosphate (15.5 % P_2O_5) at the rate of 200 kg /fed was added during the field preparation in both seasons. Sugar beet *(Beta vulgaris* L.) seeds of multigerm variety namely ATHOSPOLY at the rate of 6.0 kg/fed were planted at October 15 and November 3 in 2004/2005 and 2005/2006 seasons, respectively. However, root harvesting occurred on May 6th and 31st in the two successive seasons, respectively. Irrigation treatments were started from the second irrigation, in both seasons. The physical and chemical properties of the experimental plots described by Page *et al.* (1982) and Klute (1986) are presented in Table (1).

Table (1): Physical and chemical analysis of the experimental field (average two seasons).

(A) Physical analysis:

Coarse sand %	Fine sand %	Silt %	Clay %	Organic matter %	$CaCO_3$%	Textural class
19.0	32.2	21.0	27.8	0.84	8.20	Sandy clay loam

(B) Chemical analysis:

Analysis of soil water extract 1:5 Soluble ions meq /L			Analysis of soil water extract 1:5. Soluble cations meq /L			Available nutrients (ppm)		E.C dSm^{-1}	pH soil susp 1:2.5
CO_3^{2-} + HCO_3^-	CL^-	SO_4^{2-}	Ca^{++} and Mg^{++}	Na^+	K	N	P		
3.04	13.0	14.0	14.14	15.62	0.28	74	4	2.9	8.11

The monthly averages of climatic factors for Fayoum area during the two growing seasons period of sugar beet are recorded in Table (2). The soil moisture constants of the experimental plots are shown in Table (3). Irrigation dates, intervals and count for the different irrigation treatments are presented 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 the soil surface and down to 60.0 cm depth. The preceding crops were grain sorghum in both seasons. The other cultural practices for growing sugar beet crop at Fayoum area were adopted, according to the recommendations of Agricultural Ministry of Egypt .At harvesting date the following data were recoded for each sub- plot:

1. Yield and Yield components:

1. Root length (cm).
2. Root diameter (cm) .
3. Root weight (kg).
4. Total plant weight (kg).
5. Fresh roots yield (t/fed), was determined from the roots yield of the whole sub- plot of each treatment.

Table (2): The monthly average of climatic factors for Fayoum Governorate during sugar beet growing seasons in 2004/ 2005 and 2005/2006.

Month		Temperature °C			Relative humidity	Wind speed	Solar radiation	Class pan evaporation
		Max.	Min.	Mean	(%)	(m/ sec)	(mm/ day)	(mm/ day)
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	2.2	5.65	3.20
	2005	24.7	11.0	17.8	57	1.3	6.33	2.40
December	2004	21.6	8.1	14.8	59	2.4	4.58	1.80
	2005	21.9	8.9	15.4	59	1.7	5.38	1.96
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	1.75
February	2005	21.0	6.9	13.9	55	2.2	6.42	2.60
	2006	22.2	8.4	15.3	54	1.9	7.22	2.80
March	2005	25.2	9.4	17.3	53	2.2	8.13	4.00
	2006	26.3	9.7	18.0	52	1.7	9.60	4.80
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	5.40
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 district ".

Table (3): Average of the soil moisture constants of the experimental plots during 2004/2005 and 2005/2006 seasons.

Soil depth (cm)	Field capacity (%)	Wilting point (%)	Bulk density (g/cm^3)	Available moisture (%)
0 - 5	38.98	18.58	1.31	20.40
15-30	34.21	17.91	1.50	16.30
30-45	32.13	15.11	1.44	17.02
45-60	29.88	14.06	1.40	15.82

11. Yield quality:

1. Sucrose percentage was determined by the Sucrometer using lead acetate according to the A.O.A.C. (1965).
2. Total soluble solids (T.S.S), was determined by the Refractometer .
3. Juice purity: was calculated as follows:
   Juice purity = {(Sucrose %)/ (T.S.S%.)} x 100

4. Sugar yield (t/fed), was calculated from the sucrose percentage in fresh roots and the fresh roots yield (t/ fed) for each treatment .

All the data collected at harvesting for the yield, yield components and crop quality were subjected to the statistical analysis according to (Snedecor and Cochran, 1980). The averages were compared using the L.S.D test at the level of 5% probability.

III. Crop water relations.

1. Seasonal consumptive use (ETc).

To obtain the sugar beet consumptive use (ETc) during the growing season, soil samples were taken just before and 48 hours after each irrigation, as well as at harvesting time. The crop consumptive use (evapotranspiration) in cm between each two successive irrigations was estimated according to the following equation of Israelsen and Hansen, 1962:

$$Cu\ (ETc) = (\theta_2 - \theta_1)/100 .\ Bd.\ D$$

Where:

Cu= crop water consumptive use (cm).

θ_2= Soil moisture %, 48 hours after irrigation.

θ_1 =Soil moisture%, just before irrigation.

Bd= Bulk density of soil (gm/cm^3).

D = Soil layer depth (cm).

2. Daily ETc rate/month (mm).

Calculated from the crop consumptive use between successive irrigations from planting and during the growing season months till harvesting, divided by number of days between each two successive irrigations.

3. Reference evapotranspiration (ET0) in mm/ day.

The ET0 values in mm/ day during the growing seasons months of sugar beet crop were estimated from the monthly averages of climatic factors of Fayoum Governorate (Table 2), and using the procedures of FAO penman-Monteith equation (Allen *et al.* 1998).

4. Crop coefficient (Kc).

The crop coefficient (Kc) was calculated as follows.

$$\frac{\text{Actual crop consumptive use (ETc)}}{\text{evapotranspiration (ETo)}}$$

5. Water use efficiency (WUE).

The water use efficiency expressed as Kg fresh roots yield/ m3 water consumed was calculated for the different treatments as the method out lined by Vites (1965).

$$WUE = \frac{\text{Fresh roots yield (kg/fed)}}{\text{Crop consumptive use } (m^3/fed)}$$

Table (4): Dates of irrigations, irrigation intervals and irrigations count, as affected by irrigation treatments in 2004/ 2005 and 2005 /2006 seasons.

Number of Irrigation	Irrigation treatments							
	2004/2005							
	(I_1) 30% ASMD		(I_2) 55% ASMD		(I_3) 80% ASMD		(I_4) 65mm C.P.E	
	Date	Internal (days)	Date	Interval (days)	Date	Interval (days)	Date	Interval (days)
Planting	15/10	-	15/10	-	15/10	-	15/10	-
1st	12/11	28	12/11	28	12/11	28	12/11	28
2nd	10/12	28	10/12	28	16/12	34	22/11	10
3rd	29/12	19	7/1	28	20/1	35	19/12	27
4th	17/1	19	1/2	25	19/2	30	13/1	25
5th	3/2	17	25/2	24	21/3	30	6/2	24
6th	20/2	17 15	17/3	20	16/4	26	12/2	17
7th	7/3	14	9/4	23	-		11/3	16
8th	21/3	16	-		-		26/3	15
9th	6/4	-	-		-		10/4	15
10th	-		-		-		22/4	12
Harvesting	6/5	31	6/5	28	6/5	21	6/5	15
Irrigations count		10		8		7		11
	2005/2006							
Planting	3/11	-	3/11	-	3/11	-	3/11	-
1st	1/12	28	1/12	28	1/12	28	1/12	28
2nd	1/1	31	5/1	35	10/12/06	40	1/1	31
3rd	23/1	22	1/2	27	9/2	30	26/1	25
4th	12/2	20	26/2	25	8/3	27	15/2	20
5th	1/3	17	20/3	22	4/4	27	3/3	16
6th	16/3	15	10/4	21	30/4	26	18/3	15
7th	1/4	16	29/4	19			2/4	15
8th	15/4	14	17/5	18			16/4	13
9th	3/5	18	-	-			30/4	14
10th			-	-			14/5	14
Harvesting	31/5	29	31/5	15	31/5	32	31/5	18
Irrigations count		10		9		7		11

RESULTS AND DISCUSSION

I- Yield and Yield components

1. Yield components

The results presented in Table (5) show that increasing the available soil moisture depletion (ASMD) in the root zone of sugar beet plants from 30% to 80 % significantly decreased root diameter, root weight and total plant weight in both seasons, whereas the root length was increased but without significant differences due to the irrigation treatments. On the other hand, except for root dimeter in both seasons and total plant weight in the first one, the differences between the averages of yield components, obtained from irrigation at 65 mm cumulative pan evaporation (CPE) and those obtained from irrigation at 30% ASMD, were insignificant in the two seasons. The highest average values of root diameter, root weight and total plant weight were detected from irrigating sugar beet plants irrigated at 30% ASMD in both seasons. It is obvious that increasing the ASMD in the root zone of sugar beet plants decreased yield components, but increased the root length. The results were found to be true, since the high ASMD in the root zone enhanced water and nutrients absorption and this in turn increased cell division and plant growth, whereas soil moisture stress may encourage plant root to down elongation researching for water in down depths. These results are in the same line with those reported by Semaika *et al.* (1988) and EL-Askari *et al.* (2003).

The data listed in Table (5) revealed that the averages of all sugar beet yield components except for root length in the first season were significantly affected by nitrogen fertilizer levels in both seasons. Increasing N fertilization level from 50 to 75 kg N/ fed gave significant increases in root diameter, root weight and total plant weight in both seasons and root length in the second season, recording the highest averages. However, more increase in N fertilization level application to 100 kg N/fed resulted in pronounced decreases in all yield components of sugar beet in the two seasons, recording the lowest averages. It can be concluded that 75 kg N/fed was appropriate for maximizing the sugar beet yield components, while more increase in N level to 100 kg N/fed significantly reduced yield components than those obtained from applying 50 kg N/ fed. These results are in accordance with those reported by Sharif and Eghbal (1994), Azzazy (1998), Karam *et al.* (2002) and Bilbao *et al.* (2004).

The results recorded in Table (5) indicate that the averages of root diameter, root weight and total plant weight in 2004/2005 season and root diameter in 2005/2006 season were significantly affected by the interaction between irrigation treatments and N fertilization levels. The highest averages of these components, in the same above order, were obtained from irrigation at 30% ASMD and applying 75 kg N/fed. However, the lowest averages were resulted from irrigation at 80% ASMD combined with applying 100 kg N /fed.

2. Fresh root yield

The results illustrated in Table (5) reveal that the averages of sugar beet fresh root yield were significantly affected by irrigation treatments in the two seasons. Increasing ASMD from 30% to 55% or 80% significantly decreased its averages by 20.63% and 31.4%, in 2004 /2005 season respectively, and season by 14.80% and 29.92%, in 2005/2006 respectively. However, irrigation sugar beet plants at 65 mm CPE significantly decreased fresh root yield by 2.03 and 3.72% in the two successive seasons, respectively, ranking as the second superior treatment after irrigation at 30% ASMD (short irrigation intervals) which gave the highest averages, i.e. 20.16 and 21.76 t/fed in first and second seasons, respectively. Whereas the lowest root yield averages, i.e. 13.83 and 15.25 t/fed in the two successive seasons, were detected from irrigation at 80 % ASMD (prolonged intervals). This reduction in fresh root yield/fed associated with irrigation at 80% ASMD may referred to the effect of water deficit on decreasing yield components and dry matter accumulation and root storage capacity. These results are in harmony with those found by Semaika *et al.* (1988), Ibrahim (1990) and EL-Askari *et al.* (2003).

Table (5): Sugar beet yield and yield component, as affected by irrigation treatments, N fertilizer levels and their interaction in 2004/2005 and 2005/2006 seasons.

Treatment		2004/2005				
Irrigation	Nitrogen fertilizer levels (kg N/ fed)	Root length (cm)	Root diameter (cm)	Root weight (kg)	Total plant weight (kg)	Fresh root yield (t/ fed)
(I$_1$) 30% ASMD	N1:50 kgN/ fed	18.20	11.00	2.60	2.50	19.50
	N2: 75	19.53	12.00	2.60	3.00	23.00
	N3:100	17.00	10.00	1.00	1.75	18.00
	Mean	18.00	11.00	1.83	2.42	20.16
(I$_2$) 55% ASMD	N1:50	19.00	10.50	1.75	2.25	15.50
	N2: 75	20.00	10.50	2.25	2.75	17.50
	N3:100	17.50	10.00	1.00	1.75	15.00
	Mean	18.33	10.33	1.66	2.25	16.00
(I$_3$) 80% ASMD	N1:50	20.00	10.50	1.50	2.00	13.00
	N2: 75	20.00	11.00	1.75	2.25	16.00
	N3:100	19.00	9.50	0.90	1.75	12.50
	Mean	19.66	10.33	1.38	2.00	13.83
(I$_4$) 65 mm C.P.E	N1:50	17.50	11.00	2.00	2.50	20.00
	N2: 75	18.50	11.00	2.00	2.25	22.60
	N3:100	18.50	10.50	1.00	1.75	16.75
	Mean	18.16	10.83	1.66	2.17	19.75
Mean of N. levels:						
N$_1$: 50 kg N/ fed		18.67	10.75	1.81	2.31	17.00
N$_2$: 75 kg N/ fed		19.46	11.12	2.12	2.56	19.75
N$_3$: 100 kg N/ fed		18.00	10.00	0.97	1.75	15.56
L.S.D at 5.0%						
Irrigation (I)		N.S	0.31	0.20	0.11	0.33
N. fertilizer (N)		N.S	0.30	0.12	0.14	0.24
(I)X (N)		N.S	0.61	0.24	0.27	0.48
		2005/2006				
(I$_1$) 30% ASMD	N1:50 kgN/ fed	18.76	11.90	2.12	2.66	20.96
	N2: 75	20.40	13.10	2.90	3.37	25.16
	N3:100	18.21	10.85	1.25	1.85	19.19
	Mean	19.12	11.95	2.09	2.63	21.76
(I$_2$) 55% ASMD	N1:50	19.65	11.19	2.09	2.56	17.56
	N2: 75	20.55	11.65	2.56	3.06	21.61
	N3:100	18.61	10.56	1.19	1.72	16.44
	Mean	19.60	11.13	1.95	2.45	18.54
(I$_3$) 80%ASMD	N1:50	20.19	10.06	1.69	2.37	15.50
	N2: 75	21.10	11.19	2.31	2.85	17.56
	N3:100	19.19	10.25	1.12	1.65	12.69
	Mean	20.16	10.50	1.71	2.29	15.25
(I$_4$) 65 mm C.P.E	N1:50	18.96	11.31	2.25	2.79	20.55
	N2: 75	19.47	12.25	2.50	3.12	23.50
	N3:100	19.15	10.31	1.31	1.95	18.81
	Mean	19.19	11.29	2.02	2.62	20.95
Mean of N. levels:						
N$_1$: 50 kg N/ fed		19.39	11.11	2.04	2.60	18.46
N$_2$: 75 kg N/ fed		20.38	12.50	2.57	3.10	21.95
N$_3$: 100 kg N/ fed		18.79	10.49	1.22	1.79	18.78
L.S.D at 5.0%						
Irrigation (I)		N.S	0.21	0.08	0.07	0.66
N. fertilizer (N)		0.66	0.17	0.14	0.12	0.56
(I)X (N)		N.S	0.35	N.S	N.S	1.12

Results in Table (5) reveal that averages of fresh root yield/fed were differed significantly due to N fertilization levels in the two seasons. Increasing N fertilization level from 50 to 75 kg N/fed significantly increased fresh root yield by 16.18% and 18.90%, and consequently 75 kg N/fed gave the highest averages (19.75 and 21.95 t/fed) in 2004/2005 and 2005/2006 seasons, respectively. However, more increase in N level up to 100 kg N/fed resulted in significant decrease in sugar beet root yield (8.47% and 9.10%,) and hence application of 100 kg N/fed gave the lowest averages (15.56 and 16.78 t/fed) in the two successive seasons. The results may be due to the high values of yield components obtained from the moderate N level (75 kg N/fed). These results are in full agreement with those reported by EL-Badry (1988), Barbanti *et al.* (1994), Azzazy (1998), Ruzsanyi (2000), Karam *et al.* (2002) and Bilbao *et al.* (2004).

Data recorded in Table (5) indicate that fresh root yield of sugar beet was significantly affected by the interaction between irrigation treatments and N fertilization levels in both seasons. The highest fresh root yield, i.e 23.0 and 25.16 t/fed in 2004/2005 and 2005/2006 seasons, respectively, were detected with irrigation at 30% ASMD and applying 75 kg N/fed. However, the lowest root yield were 12.50 and 12.69 t/fed, resulted from irrigation at 80% ASMD combined with applying 100 kg N/fed in the two successive seasons. It can be concluded that irrigating sugar beet plants at 30% ASMD (high soil moisture) and applying 75 kg N/fed (moderate fertilization levels) and preferable for high root yield, under Fayoum Governorate soil conditions.

II. Yield quality:

The results presented in table (6) show that the irrigation treatments are significantly affected with sucrose percentage, total soluble solids (T.S.S.) percentage in both season and juice purity percentage in the first one. The highest average values of sucros percentage (21.66% and 21.17%) and sugar yield (4.40 and 4.64 t/fed) in 2004/2005 and 2005/2006 seasons, respectively, were obtained from irrigating sugar beet plants at 30% ASMD. Irrigation at 65mm CPE gave sucrose percentage and sugar yields approximately near to those resulted from irrigation at 30% ASMD in both seasons but without any significant differences. On the other hand, irrigation at 80% ASMD gave the highest averages of T.S.S. percentage and juice purity percentage in both seasons. It is obvious that subjecting sugar beet plants to water stress (irrigation at prolonged intervals) significantly decreased sucrose percentage and sugar yield/fed, while T.S.S.% and juice purity were increased. These results are probably due to subjecting plants to water stress reduced water and nutrients absorption and this in turn reduced photosynthesis, carbohydrate content and carbohydrate storage in roots. Also, increasing soil mosture stress increased the somatic pressure and decreased water content of the cell sap causing high concentrations of solids in storage parts. These results are in the same trend of those indicated by Davidoff and hanks (1989) and El- Askari *et al.* (2003).

The data listed in table (6) show that sugar beet yield quality characters tested were significantly affected by nitrogen fertilization levels in both seasons, except juice purity percentage in 2005/2006 season. Increasing N fertilization level from 50 to 75 kg N/fed significantly increased sucrose percentage and sugar yield by

5.13%and 21.81%, respectively, in 2004/2005 season and by 6.41% and 24.28%, respectively, in 2005/2006 season. However, increasing N level from 50 to 100kg N/fed significantly decreased sucrose percentage, purity percentage and sugar yield/fed by 10. 17% 1.04 % and 16.7%, respectively, in 2004/2005 season and by 7.15%, 1.07% and 16.45%, respectively, in 2005/2006 season, while the T.S.S. percentage increased in both seasons. These results are in agreement with those found by Prasad *et al.* (1985), EL-Badry (1988) Shepherd (1991), Barbanti *et al.* (1994) Sharif and Eghbal (1994) and Ruzsangi (2000).

Data in Table (6) indicate that the T.S.S. and juice purity percentages in 2004/2005 season and the T.S.S. percentage in 2005/2006 season were significantly affected by the interaction between irrigation treatments and N fertilization levels the highest values of T.S.S. percentage, i.e. 21.22% and 21.47% in the two successive seasons ere detected from irrigation at 80% ASMD and applyirg 100kg N/fed however, the highest juice purity percentage in 2004/2005 season (97.20%) was observed from irrigation at 80% ASMD and applying 50kg N/fed.

II- crop water relations:

1- Seasonal crop consumptive use (ETc).

The results in table (7) indicate that the seasonal consumptive use averages of sugar beet crop, as a function of irrigation treatments and N fertilization levels were 64.09 and 62.41cm in 2004/2005 and 2005/2006 seasons, respectively the difference between the two values may be due to the variation in climatic factors of the two seasons the highest averages of sugar beet consumptive use, i.e. 68.37 and 65.37 cm in 2004/2005 and 2005/2006 seasons, respectively, were detected from irrigation at 65mm cumulative pan evaporation (CPE). Irrigating sugar beet plants at 30% ASMD approximately gave similar ETc values to those of irrigation at 65mm CPE, i.e. 67.42 and 65.03cm in the two successive seasons. However, increasing the ASMD in the root zone of beet plants from 30% to 55% decreased the seasonal ETc to 61- 85 and 61.22cm in 2004/2005 and 2005/2006 seasons, respectively. More increase in ASMD from 30% to 80% caused pronounced reductions in ETc by 12.9% and 10.75% in the two seasons, respectively. It is obvious that irrigating sugar beet plants at high levels of available moisture (at short intervals) resulted in increasing the seasonal crop consumptive use. However, increasing the ASMD in the root zone caused remarkable decrease in seasonal ETc the results may referred to the lower evaporative demands from the soil and low transpiration rates from the limited vegetation of plants, subjected to water stress These results are in harmony with those reported by Doorenbos *et al.* (1979), Semaika *et al.* (1988), Davidoff and Hands (1989) Ibrahim (1990), Massoud and Shalaby (1989) and EL- Shouny *et al.* (2003).

The results presented in table (7) show that increasing N fertilization level applied to sugar beet plants from 50 to 75 and 100kg N fed increased seasonal ETc by 2.35% and 3.58% respectively, in 2004/2005 season and by 2.79% and 4.01% respectively, in 2005/2006 season. This graduate improvement may be due to that increasing N level increased number of green leaves and L.A.I of plants which in turn increased transpiration from plants these results are in accordance with those reported by Prasad *et al.* (1985), Burcky (1993) and Karam *et al.* (2002).

Table (6): Some quality characteristics of sugar beet fresh root yield, as affected by irrigation treatments, N fertilizer levels and their interaction in 2004/2005 and 2005/2006 seasons

Treatments		2004 / 2005			
Irrigation	Nitrogen fertilizer levels (kg N/ fed)	Sucrose (%)	T.S.S (%)	Juice purity %	Sugar yield (t/fed)
(I_1) 30% ASMD	N1:50	22.28	19.00	95.08	4.34
	N2:75	23.52	19.00	94.20	5.41
	N3:100	19.20	19.22	95.01	3.45
	Mean	21.66	19.07	94.76	4.40
(I_2) 55% ASMD	N1:50	20.30	19.50	96.14	3.14
	N2:75	21.36	19.00	95.84	3.74
	N3:100	18.30	20.25	94.66	2.74
	Mean	19.99	19.58	95.54	3.20
(I_3) 80% ASMD	N1:50	17.22	20.00	97.20	2.24
	N2:75	18.46	20.00	96.45	2.95
	N3:100	17.00	21.22	96.39	2.12
	Mean	17.56	20.41	96.68	2.43
(I_4) 65% Mm C.P.E	N1:50	22.00	19.50	96.72	4.40
	N2:75	22.66	19.50	94.82	5.09
	N3:100	20.58	19.77	95.09	3.45
	Mean	21.75	19.59	95.54	4.31
Means of N. levels :					
N1: 50kg N/fed		20.45	19.50	96.28	3.53
N2:75 kg N/fed		21.50	19.37	95.32	4.30
N3:100 kg N/fed		18.77	20.11	95.28	2.94
L.S.D 5.0 %					
(I) Irrigation		1.57	0.42	0.32	0.40
(N) fertilizer levels		1.21	0.28	0.18	0.28
(I) x (N)		N.S	0.57	0.37	N.S
		2005 / 2006			
(I_1) 30% ASMD	N1:50	21.46	19.00	96.45	4.50
	N2:75	22.81	19.00	95.70	5.73
	N3:100	19.81	19.62	95.99	3.69
	Mean	21.17	19.21	96.04	4.64
(I_2) 55% ASMD	N1:50	20.59	19.92	96.99	3.61
	N2:75	22.76	19.07	96.18	4.92
	N3:100	18.75	20.04	94.91	3.08
	Mean	20.70	19.68	96.20	3.87
(I_3) 80% ASMD	N1:50	18.83	20.55	97.27	2.92
	N2:75	19.48	19.90	96.59	3.42
	N3:100	17.55	21.47	96.34	2.22
	Mean	18.62	20.64	96.73	2.85
(I_4) 65% Mm C.P.E	N1:50	20.85	19.34	96.49	4.28
	N2:75	21.93	19.57	95.69	5.15
	N3:100	20.33	20.07	95.80	3.82
	Mean	21.03	19.66	95.95	4.42
Means of N. levels :					
N1: 50kg N/fed		20.43	19.70	96.80	3.83
N2:75 kg N/fed		21.74	19.38	96.04	4.76
N3:100 kg N/fed		18.97	20.30	95.76	3.20
L.S.D 5.0 %					
(I) Irrigation		0.88	0.31	N.S	0.65
(N) fertilizer levels		0.73	0.25	N.S	0.56
(I) x (N)		N.S	0.49	N.S	N.S

Results in Table (7) proved that the highest average values of ETc, i.e. 69.06 and 66.61cm in 2004/2005 and 2005/2006 seasons, respectively, were obtained from irrigating sugar beet plants at 65mm CPE and applying 100kg N/fed. However irrigation at 80% ASMD and applying 50kg N/ fed gave the lowest E.T.C values, i.e. 57.71 and 56.86cm in the two seasons, respectively.

Table (7): Seasonal consumptive use of sugar beet crop (ETc) in cm, as affected by irrigation treatments, N fertilizer levels and their interaction in 2004/2005 and 2005/2006 seasons.

Irrigation treatments	Nitrogen fertilizer levels (kg N/fed)			
	2004/2005			
	(N_1) 50	(N_2) 75	(N_3) 100	Mean
I_1: 30% ASMD	66.22	67.38	68.65	67.42
I_2: 55% ASMD	60.14	62.05	63.35	61.85
I_3: 80% ASMD	57.71	59.16	59.34	58.74
I_4: 65% C.P.E	67.32	68.74	69.06	68.37
Mean	62.85	64.33	65.10	64.09
	2005/2006			
I_1: 30% ASMD	63.82	65.23	66.03	65.03
I_2: 55% ASMD	59.23	61.62	62.82	61.22
I_3: 80% ASMD	56.86	58.32	58.93	58.04
I_4: 65% C.P.E	64.20	65.76	66.16	65.37
Mean	61.03	62.73	63.48	62.41

2. Daily ETc rate (mm/day):

The results in table (8) generally indicate that the daily ETc rater, as a function of irrigation and N level treatments were stated with low values during October and November where the vegetation of the crop during these two months has not established yet and most of the water loss was due to evaporation from soil. Thereafter, the daily ETc rater increased during January and February, as vegetative growth increased and transpiration took place beside evaporation from soil. The peak of ETC rates were occurred at March (4.34 and 4.48 mm/day in 2004/2005 and 2005/2006 seasons, respectively), as the plants reached their maximum growth and storing stage. During April and May months the ETc rate redecrased, when plants started maturity and many leaves dried until harvesting time.

The date recorded in table (8) revealed that the daily ETc rates of sugar beet were increased by increasing the available soil moisture in the root zone of the plants and increasing the N level applied. These results were found to be true during the growing season months and in both seasons. The highest daily ETc rates during the growing seasons months were detected from irrigating sugar beet plants at 30% ASMD (short intervals) and applying 100 kg N/fed. However, irrigation at 80% ASMD and applying 50 kg N/fed gave the lowest values of daily ETc rates during all the growing season month in the two seasons. The results may referred to effect of adequate soil moisture on increasing number of green leaves and leaf area of plant, which in turn increased transpiration from leaves, as well as increasing evaporation from soil .

3. Reference evapotranspiration (ET_o)

Reference evapotranspiration values, estimated from the FAO penman-Monteith method, listed in Table (9) show that the daily ET0 values were high during October and November months, then decreased during December and January months. Thereafter, the daily ET_0 rates increased again from February until May in both seasons. These obtained results are mainly due to the changes in climatic factors as shown in Table (2). In this connection, Allen *et al.* (1998) reported that the ET_0 values are dependent on the evaporative power of the air, i.e. temperature, radiation, relative humidity and wind speed.

4. Crop coefficient (Kc) .

The data listed in Table (9) reveal that the values of Kc, as a function of irrigation and N level treatments (over all mean) started with low values during October in 2004/2005 season and November in 2005/2006 season (initial growth period, i.e. sowing and seedling stage), as a result of the diffusive resistance of bare soil after planting and during seedling stage. Thereafter, the Kc values increased during December, January and February, as the crop cover percentage increased to reach its maximum values during March (1.17 and 0.99) in the two successive seasons, as a result of maximum ETc (stage of maximum growth and root storing). The Kc decreased again during April and reached low value during May, when plants were completely matured till harvesting. These results are in agreement with those reported by Doorenbos *et al.* (1979).

The results in Table (9) indicate also that the Kc values during sugar beet growing season months were decreased by increasing the ASMD . Irrigation at 30% ASMD gave the highest Kc values during the growing season months in both seasons. However, the lowest Kc values were detected from irrigation at 80% ASMD. These results are due to that increasing ASMD to 80% decreased the ETc rates during the growing season months, where the ET0 is controlled by the climatic factors only during the months.

On the other hand, increasing N fertilization level, increased the Kc values during all the growing season months, since increasing N level increased ETc during the growing season duration. It is obvious that the Kc values derived from irrigation at 3.0% ASMD and applying 75 kg N/fed, as the treatment gave the highest fresh root yield/fed during Oct., Nov., Dec., Jan., Feb., Ap. And May in 2004/2005 season were 0.59, 0.75, 0.97, 0.99, 1.21, 1.25, 0.83 and 0.60, respectively, and in 2005/2006 season were 0.0, 0.55, 0.70, 0.90, 0.96, 1.02, 0.79 and 0.50, respectively .

5. Water use efficiency (WUE).

Results presented in Table (10) show that the averages of WUE over irrigation treatments, N level and their interaction were 6.395 and 7.271 kg fresh roots/ m3 water consumed in 2004/2005 and 2005/2006 seasons, respectively. Increasing ASMD from 30% to 55% and 80% in the root zone of sugar beet plants decreased WUE by 13.5% and 24.1%, in 2004/2005 season, and by 9.6 % and 21.5% in 2005/2006 season respectively.

Table (8): The daily consumptive use rats during the growing seasons months of sugar beet crop, as affected by irrigation treatments, N fertilizer levels and their interaction in 2004/2005 and 2005/2006 .

Treatments		2004/2005							
Irrigation	N. fertilizer levels (kg N/fed)	Oct.	Nov.	Des.	Jan.	Feb.	Mar.	Ap.	May.
(I_1) 30% ASMD	N_1: 50	2.58	2.18	2.11	2.56	4.09	4.42	3.66	3.54
	N_2: 75	2.54	2.23	2.11	2.56	4.04	4.63	3.83	3.67
	N_3: 100	2.61	2.28	2.15	2.58	4.10	4.84	3.81	3.60
Mean		2.58	2.23	2.12	2.57	4.08	4.63	3.77	3.60
I_2 55% ASMD	N_1:50	2.31	2.16	2.08	2.53	3.28	4.14	3.13	2.94
	N_2: 75	2.25	2.17	2.11	2.54	3.35	4.25	3.50	3.33
	N_3: 100	2.37	2.16	2.08	2.64	3.45	4.40	3.52	3.32
Mean		2.31	2.16	2.09	2.57	3.36	4.26	3.38	3.20
I_3 80 % ASMD	N_1:50	2.2	1.88	1.79	2.25	3.26	3.77	3.04	3.00
	N_2: 75	2.20	1.98	1.86	2.28	3.26	3.72	3.88	3.59
	N_3: 100	2.21	2.02	1.89	2.29	3.24	3.67	3.86	3.73
Mean		2.21	1.96	1.85	2.27	3.25	3.72	3.79	3.47
(I_4) 65 mm C.P.E.	$N_{1:50}$	2.53	2.21	2.00	2.44	3.41	4.58	4.61	4.19
	N2:75	2.57	2.22	1.98	2.42	3.44	4.83	4.80	4.17
	N3:100	2.54	2.26	2.02	2.40	3.44	4.89	4.82	4.11
Mean		255	2.32	2.00	2.42	3.43	4.77	4.74	4.16
Mean N_1		2.41	2.11	1.99	2.44	3.51	4.23	3.76	3.44
Mean N_2		2.39	2.15	2.02	2.45	3.52	4.36	4.00	3.69
Mean N_3		2.43	2.18	2.04	2.48	3.56	4.45	4.00	3.69
Over all mean		2.41	2.15	2.02	2.46	3.53	4.34	3.92	3.61
		2005/2006							
(I_1) 30% ASMD	N_1: 50	-	1.62	1.89	2.03	3.09	4.57	4.45	3.54
	N_2: 75	-	1.65	1.94	2.19	3.25	4.63	4.49	3.51
	N_3: 100	-	1.64	1.97	2.27	3.25	4.71	4.55	3.53
Mean		-	1.64	1.93	2.16	3.20	4.64	4.50	3.53
I_2 55% ASMD	N_1:50	-	1.61	1.83	1.96	2.97	4.23	4.08	3.00
	N_2: 75	-	1.65	1.92	2.07	3.11	4.37	4.12	3.23
	N_3: 100	-	1.66	1.94	2.13	3.22	4.41	4.14	3.37
Mean		-	1.64	1.90	2.05	3.10	4.34	4.11	3.21
I_3 80 % ASMD	N_1:50	-	1.63	1.75	1.81	2.65	4.05	3.82	2.19
	N_2: 75	-	1.64	1.82	1.91	2.91	4.17	3.94	2.99
	N_3: 100	-	1.66	1.81	1.93	2.97	4.21	3.94	3.06
Mean		-	1.64	1.79	1.88	2.84	4.14	3.90	3.07
(I_4) 65 mm C.P.E.	$N_{1:50}$	-	1.63	2.01	2.08	3.16	4.75	4.50	3.19
	N2:75	-	1.64	2.07	2.13	3.44	4.79	4.52	3.26
	N3:100	-	1.62	2.06	2.25	3.45	4.87	4.56	3.17
Mean		-	1.63	2.05	2.15	3.35	4.80	4.53	3.21
Mean N_1		-	1.62	1.87	1.97	2.97	4.40	4.21	3.22
Mean N_2		-	1.64	1.94	2.08	3.18	4.49	4.27	3.25
Mean N_3		-	1.64	1.94	2.14	3.22	4.55	4.30	3.28
Over all mean		-	1.64	1.92	2.06	3.12	4.48	4.26	3.26

Table (9): The daily consumptive use rats for reference evapotranspiration (ET0) in mm/day and crop coefficient Kc during the growing season months of sugar beet crop as affected by irrigation treatments. N fertilizer levels and their interaction in 2004/2005 and 2005/ 2006.

Treatments		2004/2005							
Irrigation	N. fertilizer levels (kg N1fed)	Oct.	Nov.	Des.	Jan.	Feb.	Mar.	Ap.	May.
Reference (ET0)		4.27	2.97	2.17	2.58	3.34	3.71	4.62	6.16
(I_1)	N_1: 50	0.60	0.74	0.97	0.99	1.22	1.19	0.79	0.57
30%	N_2: 75	0.59	0.75	0.97	0.99	1.21	1.25	0.83	0.60
ASMD	N_3: 100	0.61	0.77	0.99	1.00	1.23	1.31	0.82	0.58
Mean		0.60	0.75	0.98	0.99	1.22	1.25	0.81	0.58
I_2	$N_{1:50}$	0.54	0.73	0.96	0.98	0.98	1.11	0.68	0.48
55%	N_2: 75	0.53	.073	0.97	0.98	1.00	1.15	0.76	0.54
ASMD	N_3: 100	0.56	0.73	0.96	1.02	1.03	1.19	0.76	0.54
Mean		0.54	0.73	0.96	0.99	1.00	1.15	073	0.52
I_3	N_1:50	0.52	0.63	0.82	0.87	0.98	1.02	0.79	0.50
80 %	N_2: 75	0.52	0.66	0.86	0.88	0.97	1.00	0.84	0.58
ASMD	N_3: 100	0.52	0.68	0.87	0.89	0.97	0.99	0.84	0.60
Mean		0.52	0.66	0.85	0.88	0.97	1.00	0.82	0.56
(I_4)	N_1:50	0.59	0.74	0.92	0.95	1.02	1.23	1.00	0.68
65 mm	N2:75	0.60	0.75	0.91	0.94	1.03	1.30	1.04	0.86
C.P.E.	N3100	0. 59	0.76	0.93	0.93	1.02	1.32	1.04	0.67
Mean		0.59	075	0.92	0.94	1.02	1.28	1.02	0.68
Mean N_1		0.56	0.71	0.92	0.95	1.05	1.14	0.82	0.56
Mean N_2		0.56	0.72	0.93	0.95	1.05	1.18	0.87	0.60
Mean N_3		0.57	0.74	0.94	0.96	1.06	1.20	0.87	0.60
Over all mean		0.56	0.72	0.93	0.95	1.05	1.07	0.85	0.59
		2005/2006							
Reference (ET0)		-	2.98	2.76	2.42	3.40	4.52	5.70	7.02
(I_1)	N_1: 50	-	0.54	0.68	0.84	0.91	1.01	0.78	0.50
30%	N_2: 75	-	0.55	0.70	0.90	0.96	1.02	0.79	050
ASMD	N_3: 100	-	0.55	0.71	0.94	0.96	1.04	0.80	0.50
Mean		-	0.55	0.70	0.89	0.94	1.02	0.79	0.50
I_2	$N_{1:50}$	-	0.54	0.66	0.81	0.87	.094	0.72	0.43
55%	N_2: 75	-	0.55	0.70	0.86	0.91	0.97	0.72	0.46
ASMD	N_3: 100	-	0.56	0.70	0.88	0.95	0.98	0.73	0.48
Mean		-	0.55	0.69	0.85	0.91	0.96	0.72	0.46
I_3	N_1:50	-	0.55	0.63	0.75	0.78	0.90	0.67	0.45
80 %	N_2: 75	-	0.55	0.66	0.79	0.86	0.92	0.99	0.42
ASMD	N_3: 100	-	0.56	0.66	0.80	0.87	0.93	0.69	0.44
Mean		-	0.55	0.65	0.78	0.84	0.92	0.68	0.44
(I_4)	N_1:50	-	0.55	0.73	0.86	0.93	1.05	0.79	0.45
65 mm	N2:75	-	0.55	0.75	0.88	1.01	1.06	0.79	0.46
C.P.E.	N3100	-	0.54	0.75	0.93	1.01	1.08	0.80	0.45
Mean		-	0.55	0.47	0.89	0.98	1.06	0.79	0.45
Mean N_1		-	0.54	0.68	0.82	0.87	0.98	0.74	0.46
Mean N_2		-	0.55	0 70	0.86	0.93	0.99	0.75	0.46
Mean N_3		-	0.55	0.70	0.89	0.95	1.01	0.76	0.47
Over all mean		-	0.55	0.70	0.85	0.92	0.99	0.75	0.46

However, irrigation at 65mm CPE (I_4) decreased WUE by 3.5% and 4.3% in 2004/2005 and 2005/2006 seasons, respectively when compared with irrigation at 30% ASMD. It is evident that increasing soil moisture depletion in the root zone of sugar beet reduced the water use efficiency. The highest WUE values, i.e. 7.127 and 7.975 kg fresh roots/m^3 water consumed were detected from irrigation at 30% ASMD (short intervals). These results are in harmony with those found by Doorenbos *et al.* (1979), Davidoff and Hanks (1989), Ibrahim (1990) and EL-Askari *et al.* (2003).

Data listed in Table (10) indicate that applying 75 kg N/fed gave the highest WUE values, i.e. 7.268 and 8.303 kg fresh roots /m3 water consumed in the two successive seasons. Applying 50 or 100 kg N/fed decreased WUE in 2004/2005 season by 14.03% and 22.0%, respectively, and in 2005/2006 season by 12.7% and 24.6%, respectively, compared with applying 75 kg N/fed. The highest WUE values, i.e. 8.127 and 9.184 kg fresh roots/m^3 water consumed were detected from irrigating sugar beet at 30% ASMD and applying 75 kg N/fed in 2004/2005 and 2005/2006 seasons, respectively. The results are in the same trend with those reported by Karam *et al.*, (2002).

Table (10): The average values of water use efficiency by sugar beet crop (kg fresh roots/m^3 water consumed), as affected by irrigation treatments, N fertilizer levels and their interaction in 2004/2005 and 2005/2006 seasons.

Irrigation treatments	Nitrogen fertilizer levels (kg N/fed)			
	2004/2005			
	(N_1) 50	(N_2) 75	(N_3) 100	Mean
I_1: 30% ASMD	7.011	8.127	6.243	7.127
I_2: 55% ASMD	6.136	6.715	5.638	6.163
I_3: 80% ASMD	4.772	6.439	5.016	5.409
I_4: 65% mm C.P..E	7.073	7.793	5.774	6.880
Mean	**6.248**	**7.268**	**5.668**	**6.395**
	2005/2006			
I_1: 30% ASMD	7.820	9.184	6.920	7.975
I_2: 55% ASMD	7.059	8.350	6.231	7.213
I_3: 80% ASMD	6.491	7.169	5.127	6.262
I_4: 65% mm C.P..E	7.621	8.509	6.769	7.633
Mean	**7.248**	**8.303**	**6.262**	**7.271**

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صفات المحصول والجودة والعلاقات المائية لبنجر السكر تحت ظروف نقص رطوبة التربة ومعدلات التسميد النتروجيني

محمد رجب كامل عشري [*] ، إكرام علي مجاور [**]

* معهد بحوث الاراضى والمياه والبيئة -مركز البحوث الزراعية – مصر
** قسم المحاصيل – كلية الزراعة – جامعة الفيوم

أقيمت تجربتان حقليتان بمحطة البحوث الزراعية بالفيوم (كوم اوشيم) خلال موسمي الزراعة ٢٠٠٤/٢٠٠٥و ٢٠٠٥/٢٠٠٦ حيث توافقت ٤ معاملات ري وهى: الري عند فقد ٣٠% و٥٥% و٨٠% من ماء التربة الميسر، الري عند ٦٥ مم بخر متجمع للوعاء القياسي وذلك مع ٣ معدلات للتسميد النيتروجيني وهى: ٥٠، ٧٥، ١٠٠ كجم ن/ ف في تصميم قطع منشقة ذو أربع مكررات وتم دراسة تأثير هذه المعاملات علي صفات محصول بنجر السكر ومكوناته وجودته وكذلك العلاقات المائية للمحصول وكانت أهم النتائج المتحصل عليها كما يلي:

١- تأثر قطر ووزن الجذر ، الوزن الكلي للنبات ، محصول الفدان من الجذور ، نسبة السكروز ، نسبة المواد الصبة ، نسبة النقاوة ومحصول الفدان من السكر معنويا بمعاملات الري وكذلك بمعاملات التسميد النيتروجيني في الموسمين بينما لم يكن لأي من المعاملات تأثير معنوي على طول الجذر في الموسمين.

٢- أدى زيادة فقد الماء والميسر من ٣٠% إلى ٨٠% إلى نقص معنوي في قطر وزن الجذر ، وزن النبات الكلي ، محصول الفدان من الجذور ، نسبة السكروز ، محصول الفدان من السكر بينما زادت نسبة المواد الصلبة ونسبة النقاوة للعصير .

٣- تفوق محصول الفدان من الجذور ومكوناته ونسبة السكروز ومحصول الفدان من السكر الناتج من الري عند ٦٥ مم بخر وعاء مجتمع على نفس هذه الصفات الناتجة من الري عند فقد ٥٥ % أو ٨٠ % من الماء الميسر في كلا الموسمين .

٤- أدت زيادة معدل النيتروجين من ٥٠ إلى ٧٥ كجم ن/ ف إلى زيادة معنوية في محصول الفدان من الجذور ومكوناته ونسبة السكروز ومحصول الفدان من السكر بينما نقصت نسبة المواد الصلبة ونسبة النقاوة. بينما أدت زيادة معدل النيتروجين إلى ١٠٠ كجم ن/ ف إلى نقص معنوي في المحصول ومكوناته ، ونسبة السكر و محصول الفدان من السكر في كلا الموسمين .

٥- كانت أعلى قيم لمكونات المحصول ، محصول الفدان من الجذور (٢٣,٠٠ ، ٢٥,١٦ طن/ف) ، نسبة السكروز (٢٣,٥٢ ، ٢٢,٨١%) ومحصول السكر (٥,٤١ ، ٥,٧٣ طن/ف) خلال الموسمين المتعاقبين قد نتجت من الري عند فقد ٣٠% من الماء الميسر وإضافة ٧٥ كجم ن/ف بينما أدى الري عند فقد ٨٠% من الماء الميسر وإضافة ١٠٠ كجم ن/ف إلى الحصول على أقل القيم للصفات السابقة في الموسمين .

٦- كان متوسط الاستهلاك المائي الموسمي هو ٦٤,٠٩ ، ٦٢,٤١ سم في موسمي ٢٠٠٤/٢٠٠٥ ، ٢٠٠٥/٢٠٠٦ على الترتيب كما أدى نقص الإجهاد المائي من الري عند ٨٠% إلى الري عند ٣٠% فقد ماء ميسر وزيادة معدل النيتروجين من ٥٠ إلى ١٠٠ كجم ن/ف إلى زيادة الاستهلاك المائي الموسمي من ٥٧,٧١ ، ٥٦,٨٦ سم إلى ٦٨,٦٥، ٦٦,٠٣ سم في الموسمين المتعاقبين .

٧- زاد معدل الاستهلاك المائي اليومي من أكتوبر وخلال نوفمبر وديسمبر ويناير وفبراير ليصل إلى أقصى قيمة له خلال مارس ثم انخفض مرة أخرى خلال أبريل ومايو حتى الحصاد وكان ثابت المحصول خلال شهور موسم النمو من أكتوبر حتى مايو هو ٥٩. ، ٦٥. ، ٨٤. ، ٩٥. ، ١,٠٩ ، ١,١٤ ، ٨١. ، ٥٥. على الترتيب (متوسط الموسمين) وذلك للمعاملة التي أعطت أعلى محصول جذور وسكر للفدان

٨- كانت أعلى كفاءة لاستهلاك الماء ٨,١٢٧، ٩,١٨٤ كجم جذور /م٣ ماء مستهلك في موسمي ٢٠٠٤/٢٠٠٥ . ٢٠٠٥/٢٠٠٦ على الترتيب قد نتجت من الري عند فقد ٣٠% من الماء الميسر وإضافة ٧٥ كجم ن/ف .

وعلية يمكن التوصية باستخدام التوليفة بين الري عند فقد ٣٠%من الماء الميسر مع التسميد النتروجيني بمعدل ٧٥ كجم نتروجين/فدان لزراعة بنجر السكر تحت الظروف البيئية المماثلة لما وصف بهذه التجربة، حيث أن هذه المعاملة أعطت أفضل محصول وصفات جودة واعلي كفاءة لاستخدام المياه.