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Improvement of Soil and Water Productivity for Sugar Beet under Salt Affected Soils at North Nile Delta, Egypt

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ABSTRACT

A field trial was conducted during the two consecutive growing seasons of 2016/17 and 2017/18 at Sakha Agricultural Research Station Farm, Kafr El-Sheikh Governorate. The aim of this current study was to evaluate the effect of four irrigations treatments; cut-off at 100 (I_1, traditional practice), 90%(I_2), 80% (I_3) and 70% (I_4) from furrow length and five fertilization treatments; F1 (90 Kg N Fed.$^{-1}$), F2 (67.5 kg N+3 ton compost fed.$^{-1}$), F3 (45 kg N+5 ton compost fed.$^{-1}$), F4 (22.5 Kg N+7 ton compost fed^{-1}) and F5 (10 ton compost fed.$^{-1}$) (ha =2.4 fed) on some water parameters, some soil properties and yield of sugar beet. The experiments were designed as spilt plot with three replications. The main plots were occupied by cut-off irrigation, while subplots were devoted to fertilization rates. The main results can be summarized as follows: The highest values of applied water (3678 and 3562 m^3 fed^{-1}); water consumptive use (2381 and 2210 m^3 fed^{-1}) and water stored (2525 and 2456 m^3 fed^{-1}) were recorded under I_1 (local farmers practice) in the 1st and 2nd seasons, respectively. On the other hand, the lowest values of applied water (3168 and 3094 m^3 fed.$^{-1}$); water consumptive use (2218 and 2062 m^3 fed^{-1}) and water stored (2325 and 2335 m^3 fed^{-1}) were recorded with I_4 in the 1st and 2nd seasons, respectively. The highest values of water saving was recorded under I_4 as average of the two growing seasons (12.14 cm and 11.14 cm, respectively) which saved about 100*10^6 m^3 water in sugar beet fields at the national level (200*10^3 fed) comparing with check treatment (I_1). The highest values of irrigation application and consumptive use efficiencies in both seasons were achieved under irrigation treatment I_4 but the lowest values were recorded under irrigation treatment I_1 in the two studied seasons. Concerning to water productivity (WP) and productivity of irrigation water (PIW), the highest values of WP (14.09 and 16.74 Kg m^{-3}) and PIW (9.70 and 11.61 kgm^{-3}) were recorded under I_3 in the first and second seasons, respectively. On the other hand, the lowest values of WP (12.16 and 14.99 kgm^{-3}) and IPW (7.88 and 9.30 Kgm^{-3}) were recorded with I_1 in both seasons, respectively. Concerning to the role of fertilization in WP and PIW, F_2 treatment achieved the highest values of WP (14.38 and 17.38 kg m^{-3}) and PIW (9.99 and 11.23 kg m^{-3}), while F4 treatment gave the lowest values of both parameters in both seasons, respectively The soil ECe, SAR and ESP as mean values of both seasons were affected by irrigation cut-off and fertilization treatments. The highest reduction of ECe, SAR and ESP was induced by F_5 under I_1, while the lowest reduction was recorded with F_1 and I_4. The highest root yields (18.78 and 20.61 ton fed^{-1}) were achieved with I_3, while F5 was the best fertilization treatment (15.76 and 18.13 ton root fed.$^{-1}$) in both seasons, respectively. So, the highest significant effects of cut- off and fertilization treatments on sugar beet root, shoot and sugar yields in both growing seasons were achieved with I_3 and F_5. Also, there were high significant effects on such parameters due to the interactions between different treatments.

Keywords: Sugar beet, cut-off irrigation, water productivity, fertilizer, compost

INTRODUCTION

Sugar beet is an important crop for sugar production and also, considers one of the most important cash crop in Egypt. Because of high cost of chemical fertilizers, the organic fertilizers such as farmyard manure and compost have to be used, because they contain most of macro and micronutrients. Nutrients in organic manures are released more slowly and stored in the soil (Sharma and Mittra, 1991) thus leading to higher crop yield (Abou El-Magd, *et al* 2005). Therefore, the mature composts are better than fresh and immature composts due to their higher level of stable carbon.

Javaheri *et al* (2005) found that application of 20 tons farmyard manure ha^{-1} increased the sugar yield by 10%. Mahmoud *et al*., (2014) found that adding of 5 ton compost ha^{-1} increased the root yield and improved juice quality of sugar beet. In addition, farmyard manure at the rate of 30 ton ha^{-1} increases the sugar yield by 5.41 ton ha^{-1} (Talenghani *et al*., 2006). Also, with drip irrigation system, application of 12 ton compost ha^{-1} improved root yield of sugar-beet (Masri *et al*., 2015), while with sprinkler irrigation, applying 12.5 ton compost ha^{-1} increased root weight and root yield of sugar beet. On the other hand, Mohamed, *et al*., (2018) showed that the interaction between fertilization by 216 or 288 kg N ha^{-1} and application of 12 ton ha^{-1} compost without water stress produced the maximum root and sugar yields. (Wallace and Carter, 2007) showed that the using of compost increases soil fertility and therefore, increased sugar beet root yield by 7%.

In addition to its positive effect on crop yield, the application of organic manures improves the soil physical and chemical properties. Farmyard manures have positive effects on the soil characteristics (Suja and Sreekumar, 2014), since bulk density was decreased, while organic carbon content and water holding capacity were increased (Lentz and Lehrsch, 2014). But according to Abu-Zahra and Tahboub (2008), organic matter had no significant effect on pH and EC, while it increased the available phosphorous and organic matter content in the soil. Also, (Valarini, *et al* 2009) showed that application of compost increased soil pH, and water stable aggregates. In addition, farmyard manure at the rate of 30 ton ha^{-1}, decreased the soil bulk density from 1.46 to 1.38 g cm^{-3} and increased its organic carbon content from 0.81 to 0.94% (Talenghani *et al*., 2006). Loper, *et al*, (2010) found that bulk density and pH were significantly reduced, organic matter and electrical conductivity were increased, plant growth was enhanced and N and P contents in plant tissue were higher in soils treated by compost. Also, in the soils treated by the compost, the bulk density, macro-porosity and water-filled pore space were within their optimum ranges (Carter, *et al*, 2004), aggregate stability was increased (Diacono and Montemurro, 2010) and organic carbon was increased (Adugna, 2016).

Nitrogen is the most important element for sugar beet and its production was decreased to half due to decline of N in soil (Cooke and Scott, 1993). Also, N fertilization can improve leaf area, photosynthetic rate and crop productivity (Cai and Ge, 2004). On the other hand, the N whether from inorganic or organic sources is applied to grow sugar beet profitably, where N content in the compost can satisfy its requirements without decrease in sucrose yield (Lehrsch, *et al*, 2015 a). In addition, N uptake of sugar beet was similar whether fertilized with urea or organic N (Lehrsch, *et al*, 2015 b). Consequently, not applying manure or reducing the inorganic N fertilizer rate for manure-treated soils are being recommended (Blumenthal, 2001).

The effective N management is essential for the profitable production of sugar beet (Hergert, 2010) and N management is closely linked with soil water relationships (Coyne 2008). Mohamed, *et al*, (2018) showed that decreasing nitrogen from 100% to 75% of the recommended rate significantly decreased root and sugar yields, but increased sucrose %. On the other hand, El-Hassanin *et al*, (2016) found that decreasing N application from 225 kg to 108 kg/ha significantly decreased sucrose % and yield of sugar beet. Masri *et al*. (2015) reported that increasing nitrogen rate from 150 up to 300 kg N ha^{-1} significantly increased the sugar beet yield. Also, increasing N rate up to 300 kg N ha^{-1} significantly increased leaf area index, individual root weight, root number and root yield, while excessive N application lowered beet quality (Masri *et al*, 2015). In the contrast, (Mustafa, 2007) found that nitrogen and phosphorus had no significant effect on leaf number, leaf area index, shoots and root weight, sugar content % and root contents from N, P, K and Na.

Finally, the long term applications of compost improve plant growth by steadily supplying the mineralized N (Diacono and Montemurro, 2010). Thus, replacing expensive inorganic N with less expensive organic N fertilizer may be benefit for sugar beet producer (Lentz and Lehrsch, 2012).

Cut-off irrigation is considered as the most practical ways to save water in surface irrigation particularly in heavy textured soils. This procedure reduces amounts of tail end drainage water, while the advancement movement of the accumulated water after cut-off is used to irrigate the un-irrigated area. Several investigations were conducted to evaluate the optimum length of irrigation run at which achieves the highest yield and proper water efficiency. For instance, Ibrahim and Emara (2009) reported that irrigation cut off at 90% of furrow length achieved the highest sugar beet yield and save about 300 $m^3 fed.^{-1}$ comparing to that with 80% or 100%. Also, Kassab and Ibrahim, (2007) found that the seasonal water applied with different cut off can be arranged as the following descending order: 100%> 95%> 90%> 85%> 80%. This trend may be attributed to that deep percolation and runoff losses were less with the cut-off method compared to the conventional method (Mostafazadeh and Farzamnia, 2000).

The withholding of irrigation at specific times before crop harvesting is another way to save water. The increase of irrigation cutoff date from 10 to 40 days before sugar beet harvest reduced its root yield but increased total and white sugar content and can increase the irrigation efficiency (Sohrabi and Heidari, 2008). Also, 4 to 6 inches of irrigation water applied to sugar beet can be saved by cutting off irrigation 6 to 7 weeks before harvesting Kaffka, *et al* (1998). On the other hand, when irrigation was cut off in mid-August, sugar yield declined 7% comparing to the full season irrigation (Yonts, *et al*., 2003). For fodder beet, the lowest roots or tops yields were obtained by withholding the 2nd irrigation followed by withholding the 4th irrigation compare to the full irrigation (Hussein and Siam, 2012). On the other side, Mirzaei and Rezvani, (2007) found that irrigation cutoff at the end of sugar beet growth reduced sugar content and white sugar yield. Saffarian *et al*, (2006) showed that early irrigation cutoff at harvest increased the sugar content.

The production and water use efficiency of sugar beet are affected by deficit irrigation or water stress. Therefore, deficit irrigation is one of the ways to maximize water use efficiency (Kirda ,2002), but it significantly decreased root, shoot and sugar yields comparing to full irrigation, while sugar % was not affected (Mehrandish, *et al*, 2012). In addition, sugar production with water deficit at 40% water holding capacity was less than that at 60% (Mubarak, *et al* 2016). Also, the water stress increasing up to 50% of water requirement significantly decreased root and sugar yields, while it increased sucrose content (Mohamed, *et al*, 2018).

The objective of the present study is to evaluate the role of fertilization (compost combined with N) as well as length of irrigation run (cut-off irrigation practice) on water saving and sugar beet yield.

MATERIALS AND METHODS

A field trial was conducted at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, Egypt during two consecutive winter seasons (2016/17 and 2017/18). The site lies at 134 Km north Cairo and has an elevation of about 6 meters above mean sea level with coordinates of 18 31 17.6 latitude and 48 30 20.9 longitude. The objective was to study the effect of four irrigation treatments; cut-off at100% (control, like local farmers practice in the study area), 90%, 80% and 70% of furrow length and five fertilization rates (F_1: 90 kg Nfed^{-1}, F2 67.5 kg N fed^{-1}+ 3 ton compost fed^{-1}, F3: 45kg N fed^{-1} + 5 ton compost fed^{-1}, F4: 22.5 kg N fed^{-1} + 7 ton compost fed^{-1} and F5: 10 ton compost fed^{-1}) on some water relations, some soil properties and yield of sugar beet crop.

The experiment was conducted in a split plot design, with three replications. The plot area was 1500 m^2 (15×100 m) for irrigation treatments, while it was 300 m^2 (15 m × 20 m^2) for fertilization treatments. The main plots were assigned to cut-off irrigation, while the sub-plots were devoted to fertilization rates as shown in Table (1).

Table 1. The experimental treatments

	Irrigation cut-off treatments
I_1	Cut-off at 100 % of furrow length (control)
I_2	Cut-off at 90 % of furrow length
I_3	Cut-off at 80 % of furrow length
I_4	Cut-off at 70 % of furrow length
	Fertilization treatments
F_1	90 kg N fed^{-1}
F_2	67.5 kg N fed^{-1} + 3 ton compost $fed.^{-1}$
F_3	45 kg N fed^{-1} + 5 ton compost $fed.^{-1}$
F_4	22.5 kg N fed^{-1} + 7 ton compost $fed.^{-1}$
F_5	10 ton compost $fed.^{-1}$

Sugar beet (Beta Vulgaris) was sown on October 5th, 2016 and harvested on May, 15th, 2017 in the 1st season, while in the 2nd season the sowing date was on October, 10th, 2017 and harvesting was on May 10th, 2018. The N was applied as urea form (46.5% N). The other cultural practices for sugar beet were performed as recommended in this region. The following data were recorded: yield (ton fed^{-1}) and sucrose (%). The agrometeorological data during the two growing seasons were obtained from Sakha Station as presented in Table (2).

Tale 2. Some meteorological data of Kafr El-Sheikh area during the two growing seasons*.

Months	Temperature, C°			Relative humidity %			Wind velocity	Pan-evaporation	Rain
	Max	Mini	Mean	Max	Mini	Mean	(km/24 h)	(cm day^{-1})	(mm /month)
						1st season			
Oct.,2016	29.8	21.7	25.8	82.4	55.3	68.8	92.2	0.357	—
Nov.,2016	24.9	17.9	21.4	77.9	56.8	67.4	56.0	0.198	—
Dec.,2016	19.3	10.8	15.0	85.4	65.1	75.3	64.7	0.156	25.8
Jan.,2017	18.2	5.7	11.9	87.3	62.9	75.1	51.9	0.136	9.6
Feb.,2017	19.7	10.2	14.9	85.8	60.1	72.6	59.3	0.214	25.2
Mar.,2017	21.7	17.9	19.8	84.9	60.4	72.7	83.8	0.295	—
Apr.,2017	26.0	21.6	23.8	79.4	50.8	65.1	89.3	0.464	15.9
May.,2017	30.6	25.8	28.2	77.7	45.6	61.6	106.5	0.659	—
						2nd season			
Oct.,2017	28.7	24.0	26.3	81.1	54.7	67.9	73.2	0.326	—
Nov.,2017	23.7	19.9	21.8	84.1	58.6	71.6	53.2	0.206	—
Dec.,2017	21.5	18.4	19.9	88.2	64.8	76.5	42.9	0.148	5.6
Jan.,2018	19.3	13.9	16.6	88.4	63.7	76.1	49.3	0.185	36.4
Feb.,2018	21.6	14.6	18.1	87.6	63.4	75.5	34.7	0.278	36.4
Mar.,2018	25.4	16.6	21.0	82.3	48.3	65.30	46.4	0.422	—
Apr.,2018	27.8	20.0	23.9	80.9	43.9	62.4	74.0	0.532	—
May,2018	31.2	23.8	27.5	75.6	43.9	59.7	95.80	0.634	—

*** Source: Meteorological Station in Sakha Agricultural Research Station.**

Before performing treatments, soil samples at different depths up to 60 cm were randomly collected and analyzed for pH, EC according to Page *et al*, (1982). Soil bulk density was measured according to (Black and Hartge, 1986). Particle size distribution was determined according to piper, (1950). Cation exchange capacity (CEC) was determined (as meq/100 g) by ammonium acetate methods according to Bower *et al* (1952) and ESP was calculated according to (Richard, 1954). Infiltration rate was measured using double ring according to Garcia, (1978). Gypsum requirements (4.9 ton $fed.^{-1}$) to reduce the ESP from 17.5% to 10% for upper 30 cm soil layer were determined according to the methods described by V.S., Salinity laboratory staff (FAO and IIASA 2000). Compost and gypsum were added before planting of sugar beet.

Some chemical and physical properties of the studied soil and compost are shown in Tables (3,4 and 5).

Table 3. Some chemical properties of the soil before cultivation of sugar beet.

Depth (cm)	EC (dS m^{-1})	pH	SAR	ESP	CEC	Soluble cations $megl^{-1}$				Soluble anions meg L^{-1}			
						Ca^{+2}	Mg^{+2}	Na^{+1}	K^{+}	CO_3^{-2}	HCO_3^{-}	Cl^{-1}	SO_4^{-2}
						1st season							
0.20	6.58	8.6	14.9	16.5	38.4	7.9	11.8	46.7	0.5	0.0	6.0	33.3	27.6
20-40	7.43	8.8	15.7	17.6	37.3	8.9	13.6	52.5	0.7	0.0	6.5	37.4	31.9
40-60	8.25	8.9	16.4	18.6	35.8	9.9	15.4	58.3	0.9	0.0	8.5	41.4	34.6
Mean	7.42		15.7	17.6	37.2	8.9	13.6	52.5	0.7	0.0	7.0	37.4	31.6
						2nd Season							
0-20	5.86	8.5	14.2	16.46	39.20	7.0	10.3	41.8	0.4	0.0	5.50	29.9	24.1
20-40	6.23	8.7	14.6	16.82	38.60	7.5	11.1	44.4	0.6	0.0	6.0	30.7	26.9
40-60	7.49	8.8	15.7	17.96	37.10	9.0	13.7	52.9	0.7	0.0	7.5	38.7	30.10
Mean	6.53		14.8	17.08	38.10	7.83	11.7	46.37	0.5	0.0	6.17	33.1	27.13

Table 4. Some physical properties and some water constants of the soil before cultivation of sugar beet.

Depth (cm)	Particle size distribution (%)			Textural class	Basic IR (cm hr^{-1})	Bulk density (Mgm^{-3})	Soil Moisture constant (%)		
	Sand	Silt	Clay				Field capacity	Wilting point	Available water
					1st season				
0-20	14.68	29.50	55.82	Clayey	0.65	1.32	44.62	23.91	20.71
20-40	16.31	28.78	54.91	Clayey		1.38	42.36	22.87	19.49
40-60	18.79	27.96	53.25	Clayey		1.46	39.28	20.59	18.69
Mean	16.59	28.75	54.66	Clayey		1.39	42.09	22.46	19.63
					2nd Season				
0 – 20	16.79	28.50	54.71	Clayey	0.68	1.31	43.78	23.25	20.53
20 – 40	18.33	27.85	53.84	Clayey		1.36	41.93	21.81	20.12
40 – 60	20.15	27.16	52.69	Clayey		1.41	38.87	19.35	19.52
Mean	18.42	27.83	53.75	Clayey		1.36	41.53	21.50	20.06

Table 5. Some chemical characteristics of rice straw compost.

EC (dSm^{-1})	pH	C%	OM%	C/N ratio	N %	P%	K%	Fe ppm	Zn ppm	Mn ppm	Moisture (%)
3.16	7.67	29.80	51.26	19.10	1.56	0.86	1.15	148	65	128	28.90

Water relations:

1- Applied water (AW): Submerged flow orifice with fixed dimension was used to convey and measure the applied water, as the following equation (Michael, 1978).

$$Q = CA\sqrt{2gh}$$

Where:

Q = Discharge through orifice (cm^3 sec^{-1}).
C = Coefficient of discharges (0.60).
A = Cross sectional area of orifice (cm^2).
g = Acceleration due to gravity (980 cm/ sec^2).
h = Pressure head over the orifice center (cm).

2 -Soil moisture percentage: Soil samples were taken from each 20 cm depth interval up to 60 cm before and after the irrigations to determine moisture content and to calculate the amount of consumed water and stored for each irrigation.

3-Water consumptive use (WCU): was calculated as m3 fed.-1 using the following equation (Hansen *et al.*, 1979).

$$WCU = \sum_{i=1}^{i=n}\left\{\left(\frac{\theta_2-\theta_1}{100}\right) * Dbi * Di * 4200\right\}$$

Where:

θ_2 : Gravimetric soil moisture % after irrigation
θ_1 : Gravimetric soil moisture % before the next irrigation
Dbi : Bulk density in g / cm^3 of other 1th layer
i : No. of soil layers
n : No. of irrigation
Di : Soil layer depth (20 cm)

4 – Stored water in the effective root zone (SW): was calculated using the following equation:

$$SW = \sum_{i=1}^{i=n}\left\{\left(\frac{\theta_2-\theta_1}{100}\right) * Dbi * Di * 4200\right\}$$

θ_2 : Soil moisture % after irrigation with 48 hours in the 1st layer
θ_1 : Soil moisture % before the same irrigation in the 1th layer
Dbi : Bulk density in g / cm^3 of other 1th layer
i : No. of soil layers
n : No. of irrigation
Di : Soil layer depth (20 cm)

5 - Irrigation application efficiency (E_a): It was calculated as described by (Downy, 1970) according to the following equation:

$$E_a = \left(\frac{w_s}{w_a}\right) * 100$$

Where:-

E_a = Water application efficiency (%)
w_s= Water stored in the root zone
w_a = Water applied to the field plot.

6- Consumptive use efficiency (CUE, %): It was calculated according to (Doorenbos and Pruitt, 1975) as follows:

$$CUE = \left(\frac{ET_c}{IWA}\right) * 100$$

Where:

ET_c : Water consumptive use, and IWA: irrigation water applied to the field (m^3 fed.$^{-1}$).

7-Water distribution efficiency (WDE, %): It was calculated according to James, (1988) as follows:

$$WDE = \left(1-\frac{y}{d}\right) * 100$$

Where:-

d = average depth of soil water stored along the furrow length during the irrigation,
y = average of numerical deviation from d.

8– Water productivity (WP):- It was calculated according to Ali *et al*, (2007).

$$WP = \frac{RY}{ET}$$

Where:

WP= Water productivity
RY: Root yield (kg fed^{-1}),
ET: Total water consumption of the growing season (m^3 fed^{-1}).

9- Irrigation water productivity (IWP): Was calculated according to (Ali *et al.*, 2007) as follows:-

$$IWP = \frac{GY}{I}$$

Where:

GY: Grain yield (kg fed^{-1}),
I : Is irrigation applied water (m^3 fed^{-1}).

Statistical analysis: The data were analyzed statistically by a general linear model procedure and 2-way analysis of variance (ANOVA) using cohort computer program according to the method of Gomez and Gomez, (1984). Mean separation procedure was performed using LSD's test at a 0.05 and 0.01 level of significance.

RESULTS AND DISCUSSION

1- Seasonal applied water (SAW):

Data in Table (6) showed that the values of SAW to sugar beet were clearly affected by irrigation treatments in both growing seasons. The highest values of SAW in both seasons are 3678 m^3 fed^{-1} (87.57 cm) and 3562 m^3 fed^{-1} (84.81 cm), respectively were recorded under I_1. On the other hand, the lowest SAW values were recorded under irrigation treatment of I_4 in the two seasons (3168 m^3 fed^{-1}, 75.43 cm, and 3094 m^3 fed^{-1}, 73.67 cm, respectively). Generally, the values of SAW in the two seasons can be descended in order: I_1> I_2> I_3>I_4. So, it can be noticed that SAW decreased with decreasing irrigation run lengths in treatments which exposed to water stress. Therefore, the highest values of water saving comparing to I_1 were recorded with I_4 in both seasons (13.9% and 13.1%, respectively) followed by I_3 and I_2 treatments. These results are in a great harmony with those obtained by Ibrahim and Emara, (2009) and Kassab and Ibrahim, (2007).

Table 6. Seasonal applied water and water saving as affected by irrigation cut-off.

Irrigation treatments	1st season				2nd season			
	Applied water		Water saving		Applied water		Water saving	
	cm	m^3 fed^{-1}	%	m^3 fed^{-1}	cm	m^3 fed^{-1}	%	m^3 fed^{-1}
I_1	87.57	3678	–	–	84.81	3562	–	–
I_2	83.14	3492	5.06	186	80.64	3387	4.91	175
I_3	78.93	3315	9.87	363	77.38	3250	8.76	312
I_4	75.43	3168	13.86	510	73.67	3094	13.14	468

2- The seasonal water consumptive use, CU (m^3 fed^{-1}):

The seasonal CU is a direct function of the soil water status which already affected by the amount of irrigation applied water and it had the same trend of seasonal applied water. The seasonal CU values were decreased and CUE values were increased with decreasing irrigation run lengths in the treatments exposed to water stress. Data presented in Table (7) showed that the highest seasonal CU values in the 1st and 2nd seasons are 2381 and 2210 m^3 fed^{-1}, respectively were recorded under I_1, comparing with other treatments that subjected to water stress. Meanwhile, the lowest CU values are 2218 m^3 fed^{-1} and 2062 $m^3 fed^{-1}$ were achieved with I_4 during both seasons, respectively. On the other hand, the consumptive use efficiency (CUE) was increased from 64.74 % to 70.00% in the 1st season and from 62.00 % to 66.75 % in the 2nd season when irrigation run decreased from 100% to 70% from furrow length. The results are in somewhat agreed with El-Ramady *et al*, (2013) and El-Hadidi *et al*, (2016).

Table 7. Water consumptive use (CU) and consumptive use efficiency (CUE) as affected by irrigation treatments.

growing Season	Irrigation treatments	CU ($m^3 fed^{-1}$) Soil depth (cm) 0 - 20	20 - 40	40 - 60	Total	CUE (%)
1st season	I_1	978	885	518	2381	64.74
	I_2	971	846	498	2315	66.30
	I_3	952	836	485	2273	68.57
	I_4	944	825	449	2218	70.00
2nd season	I_1	945	838	427	2210	62.00
	I_2	938	831	416	2185	64.51
	I_3	930	815	398	2144	65.97
	I_4	898	789	375	2062	66.75

3- Stored water in the effective root zone (m^3 fed^{-1}):

The values of stored water were decreased with decreasing of irrigation run from 100% to 70% of furrow length. Data listed in Table (8) showed that the mean values of stored water in the effective root zone were decreased with cut-off irrigation treatments I_2, I_3 and I_4. The highest mean values of water stored during the two growing seasons (2525 and 2456 m^3 fed^{-1}, respectively) were recorded under irrigation treatment I_1. On the other hand, the lowest values in both seasons (2325 and 2335 m^3 fed^{-1}, respectively) were recorded under irrigation treatment I_4. These results are in agreement with those obtained by (Lentz and Lehrsch, 2014).

Table 8. Stored water, irrigation application efficiency (E_a) and water distribution efficiency (WDE) as affected by irrigation cut-off.

Growing season	Irrigation treatments	Water stored (m^3 fed^{-1}) Soil depth (cm) 0-20	20-40	40-60	Total	E_a (%)	WDE %
1st season	I_1	1081	922	522	2525	68.7	74.68
	I_2	1059	910	512	2481	71.0	74.60
	I_3	1003	875	492	2370	71.5	74.85
	I_4	983	860	482	2325	73.4	74.80
2nd season	I_1	1063	918	475	2456	69.0	72.01
	I_2	1057	910	456	2423	71.5	71.10
	I_3	1053	886	439	2378	73.2	70.30
	I_4	1033	871	431	2335	75.5	70.25

Irrigation water efficiencies:

1. **Irrigation application efficiency (E_a):** The highest values of E_a are 73.4 and 75.5% were achieved with I4 (cut-off at 70%) in the 1st and 2nd seasons, respectively, while the lowest values (68.7 and 69.0%, respectively) were resulted from I_1 as shown in Table (8). Consequently, the mean values of E_a were increased with decreasing irrigation run from 100 to 70 % of furrow length in both seasons. The results are in somewhat agreed with those obtained by (Mosalm, 2009), El-Ramady *et al*, (2013) and El-Hadidi *et al*, (2016).

Consumptive use efficiency (CUE): Consumptive use efficiency (CUE) parameter shows the capability of plants to utilize the soil moisture stored in the effective root zone. It is obvious from the obtained data that the values of CUE were increased with decreasing the irrigation run length from 100 to 70% of furrow length. Data in Table (7) showed that the highest values of consumptive use efficiency in the 1st and 2nd seasons were recorded with I_4. On the other hand, the lowest CUE values in both seasons (64.7 and 62.0%, respectively) were achieved with I_1. These findings are somewhat agree with those obtained by (Kassab, *et al*, 2007), (Kassab, 2012) and (Khalifa, 2013).

Water distribution efficiency (WDE): It is obvious from the obtained data that the values of WDE increased with decrease of the irrigation run length (Table 8). The highest values of WDE in the 1st and 2nd seasons are 74.85 and 72.01% were achieved with I_3 and I_1, respectively, while the lowest values (74.6 and 70.25%) were resulted from I_2 and I_4 in the 1st and 2nd seasons, respectively.

4. **Water productivity (WP) and irrigation water productivity (IWP):** Data in Table (9) showed the effect of cut-off and fertilization treatments on WP and IWP, whereas the highest values were achieved with I_3, may be due to decrease in amount of applied water with this treatment. The corresponding values are 14.09 and 9.70 kg total yield m^{-3}, respectively in the 1st season and 16.74 and 11.04 Kg total yield m^{-3}, respectively in 2nd season. Regarding the fertilization rates, F_2 treatment achieved the highest values of WP and IWP in 1st season (14.38 and 9.66 kg total yield m^{-3}, respectively) and in 2nd season (17.38 and 11.23kg total yield m^{-3}, respectively). These results are in the same line with those obtained by Ibrahim and Emara, (2009) and Kassab and Ibrahim, (2007).

Table 9. Water productivity (WP) and Irrigation water productivity (IWP) of sugar beet as affected by different treatments

Treatments	1st growing season								2nd growing season							
	WP (kg m-3)				IWP (kgm-3)				WP (kgm-3)				IWP (kgm-3)			
	Root	Shoot	Sugar	Total	Root	Shoot	Sugar	Total	Root	Shoot	Sugar	Total	Root	Shoot	Sugar	Total
Irrigation treatments (I)																
I_1	7.07	3.87	1.22	12.16	4.58	2.51	0.79	7.88	8.78	4.59	1.62	14.99	5.44	2.85	1.01	9.30
I_2	7.60	4.20	1.42	13.22	5.04	2.78	0.94	8.76	9.14	4.89	1.72	15.75	5.86	3.10	1.12	10.08
I_3	8.12	4.40	1.57	14.09	5.59	3.03	1.08	9.70	9.62	5.33	1.79	16.74	6.34	3.52	1.18	11.04
I_4	7.30	3.92	1.49	12.71	5.11	2.75	1.04	8.90	9.07	4.60	1.78	15.45	7.36	3.06	1.19	11.61
Fertilization treatments (F)																
F_1	7.15	3.86	1.34	12.35	4.83	2.61	0.90	8.34	8.74	4.57	1.63	14.94	5.66	2.96	1.04	9.66
F_2	8.17	4.59	1.62	14.38	5.52	3.10	1.04	9.66	9.99	5.40	1.99	17.38	6.43	3.51	1.29	11.23
F_3	7.91	4.29	1.51	13.71	5.34	2.89	1.02	9.25	9.57	5.09	1.82	16.48	6.21	3.29	1.18	10.68
F_4	7.51	4.07	1.42	13.00	5.08	2.75	0.96	8.79	9.02	4.86	1.69	15.57	5.85	3.11	1.08	10.04
F_5	6.67	3.67	1.25	11.59	4.64	2.47	0.84	7.95	8.43	4.34	1.54	14.31	5.46	2.77	1.00	9.23

5. Some soil chemical properties:

1. Soil Salinity (EC_e):

As shown in Tables (10 and 11), the mean values of EC_e before performing the experiment are 7.42 and 6.53 dSm^{-1} in the 1st and 2nd growing seasons, respectively, (Table 3), but their mean values of both seasons after harvesting were decreased to 4.85, 5.40, 5.79 and 6.19 dSm^{-1}, with I_1, I_2, I_3 and I_4 treatments, respectively. The corresponding reductions in soil salinity after harvesting with these irrigation treatments were 30.7, 22.8, 17.2 and 13.3%, respectively.

Table 10. EC, SAR and ESP of soil 60-cm surface layer after harvesting of sugar beet as affected by different treatments.

Treatments	1st season			2nd season			Overall mean		
	EC (dSm^{-1})	SAR	ESP	EC (dSm^{-1})	SAR	ESP	EC (dSm^{-1})	SAR	ESP
Irrigation treatments (I)									
I_1	5.36	12.17	14.25	4.33	10.96	12.76	4.85	11.57	13.51
I_2	5.98	12.89	15.05	4.82	11.59	13.66	5.40	12.24	14.36
I_3	6.32	13.26	15.45	5.25	12.10	14.21	5.79	12.68	14.83
I_4	6.75	13.72	15.93	5.62	12.52	14.67	6.19	13.12	15.30
Fertilization treatments (F)									
F_1	7.46	14.45	16.67	6.05	13.01	15.20	6.76	13.73	15.94
F_2	6.82	13.88	16.11	5.50	12.41	14.56	6.16	13.15	15.34
F_3	6.39	13.38	15.58	5.05	11.88	13.98	5.72	12.63	14.78
F_4	5.23	12.09	14.56	4.68	11.44	13.14	4.96	11.77	13.85
F_5	4.55	11.26	13.30	3.75	10.22	12.14	4.15	10.74	12.72

Table 11. Relative change (±%) of some soil chemical properties after harvesting of sugar beet crop as affected by different treatments.

Treatments	1st season			2nd season			Mean (-)		
	EC	SAR	ESP	EC (%)	SAR	ESP	EC	SAR	ESP
Irrigation treatments (I)									
I_1	27.8	21.0	18.8	33.7	26.05	25.29	30.7	23.5	22.1
I_2	19.4	16.4	14.3	26.2	21.79	20.02	22.8	19.1	17.1
I_3	14.8	13.9	12.0	19.6	18.35	16.80	17.2	16.2	14.4
I_4	9.0	11.0	9.2	13.9	15.52	14.11	13.3	8.8	11.7
Fertilization treatments (F)									
F_1	0.5	6.2	5.01	7.4	12.21	11.01	3.9	9.2	8.0
F_2	8.1	9.9	8.21	15.8	16.26	14.75	11.9	13.1	11.5
F_3	13.9	13.2	11.23	22.7	19.84	18.15	18.3	16.5	14.7
F_4	29.5	21.5	17.04	28.3	22.81	23.07	28.9	22.2	20.1
F_5	38.8	26.9	24.22	42.6	31.04	28.92	40.7	29.0	26.6

Concerning the effect of fertilization treatments, soil salinity are decreased to 6.76, 6.16, 5.72, 4.96 and 4.15 dSm^{-1} with F_1 (90 kg N), F_2 (67.5 kg + 3 ton compost), F_3 (45 kg N+ 5 ton compost), F_4 (22.5 kg N+ 7 ton compost) and F_5 (10 ton compost), respectively compared with EC_e before experiment. The reduction of salinity due to these treatments after harvesting was 3.9, 11.9, 18.3, 28.9 and 40.7%, respectively as shown in Table (11). It can be noted that the best reduction in EC_e were achieved with F_4 and F_5 treatments (high rate of compost) under I_1 and I_2 (high amount of water applied). The decrease in EC could be attributed to the higher amount of the inorganic NPK fertilizers which were uniformly added through soil application. So, application of compost on salt affected soils helps to diminish salinity thereby improving soil characteristics, mainly by the increase of salts leaching (Leaon, 1995). Also, the application of compost and gypsum has been reported to positively affect the saline sodic soils properties under semi-arid conditions (Madejon, *et al*, 2001) and (Sundhari *et al*., 2018).

Soil alkalinity (SAR and ESP): Soil sodicity in terms of ESP as well as SAR of the soil were decreased considerably due to application of irrigation and fertilization treatments. As shown in Tables (10 and 11), the cut-off irrigation treatments significantly decreased the soil SAR and ESP values compared to that obtained before experiment. The treatments I_1 and I_2 were more effective in reducing the soil SAR and ESP as compared with I_3 and I_4 treatments. It can be noted that the highest reduction in SAR and ESP comparing to that obtained before experiment were achieved with I_1 (-23.5 and -22.1%, respectively) and I_2 (-19.1 and -17.1%, respectively). On the other hand, the lowest reduction of SAR and ESP were recorded with I_3 (-16.2 and -14.1 %, respectively) and I_4 (-8.8 and -11.7 %, respectively). These reduction rates of both parameters may be related to the amount of irrigation water applied with cut-off irrigation treatments.

Regarding to fertilization treatments, the reduction in soil SAR and ESP, respectively with different treatments as a mean of both seasons can be arranged in the following rising order: F_1 (9.2 and 8.0%) <F_2 (13.1 and 11.5 %) < F_3 (16.5 and 14.7 %) < F_4 (22.2 and 20.1%) < F_5 (29.0 and 26.6%). The different reduction rates of both parameters may be related to the amount of compost with these treatments. The results are in accordance with the findings of Chaudhary *et al*,(2004), Gharaibeh *et al*, (2011) and Abdel-Fattah, (2012).

6. Yield and yield components of the sugar beet:

1. **Root yield:** Data presented in Table (12) clearly illustrated that the values of sugar beet root yield were highly significantly affected by irrigation cut-off and fertilization treatments in the two growing seasons. The highest root yield values were achieved with I_3 treatment in both growing seasons (18.54 and 20.61 ton fed^{-1}, respectively) while, the lowest values were recorded with irrigation cut-off treatment of I_4 (16.19 and 18.70 ton fed^{-1}, respectively). Generally the root yield can be descended in order of $I_3 > I_2 > I_1 > I_4$. The increasing of root yield with I_1, I_2 and I_3 treatments may be attributed to that they received large amount of seasonal water applied which consequently decreased soil salinity and sodicity. These results are in a great harmony with those obtained by Aiad *et al*, (2014) and Moursi and Darwesh, (2014).

Regarding the effect of fertilization treatments, the root yield was highly significantly affected by these treatments in the 1st and 2nd growing seasons. In both seasons, the treatment of F_2 achieved the highest root yield values (18.78 and 21.48 ton fed^{-1}, respectively), while the lowest root yield values were recorded with F_5 (15.76 and 18.13 ton fed^{-1}, respectively). So, the root yield as affected by fertilization treatments in the two growing seasons can be descended in order F2 > F3 > F4 > F1 and F5. These results are supported by (Moursi and Darwesh, 2014).

Table 12. Sugar beet yield and sucrose content as affected by irrigation and fertilization treatments.

Treatments	Sugar beet yield (ton fed^{-1})						sucrose %	
	Root		Shoot		Sugar			
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
			Irrigation cut - off					
I_1	16.83	19.38	9.22	10.15	2.91	3.58	17.2	18.4
I_2	17.58	19.98	9.71	10.68	3.29	3.77	18.7	18.7
I_3	18.54	20.61	10.04	11.43	3.59	3.83	19.4	19.2
I_4	16.19	18.70	8.07	9.48	3.31	3.58	20.5	19.8
f. test	**	**	**	**	*	*	**	**
L.S.D								
0.05	0.364	0.417	0.323	0.384	0.101	0.268	0.280	0.392
0.01	0.502	0.585	0.445	0.546	0.140	0.311	0.403	0.542
			Fertilization					
F_1	16.44	18.79	8.89	9.82	3.07	3.50	18.7	18.6
F_2	18.78	21.48	10.56	11.63	3.73	4.12	19.8	20.0
F_3	18.17	20.56	9.86	10.94	3.45	3.91	19.3	18.5
F_4	17.27	19.39	9.35	10.46	3.25	3.62	18.9	19.0
F_5	15.76	18.13	8.43	9.32	2.86	3.30	18.1	18.0
f. test	**	**	**	**	*	*	**	**
L.S.D.								
0.05	0.362	0.369	0.319	0.309	0.100	0.261	0.199	0.378
0.01	0.487	0.436	0.428	0.415	0.134	0.351	0.267	0.508
			Interaction					
I x F	**	**	**	**	*	*	**	**

2. **Shoot yield:** The results in Table (12) showed that cut-off irrigation treatments had high significant effect on shoot yield in the two growing seasons. The highest shoot yield were recorded with I_3 treatment (9.71 and 10.68 ton fed^{-1}) while the lowest yield were recorded under I_4 treatment (8.07 and 9.48 ton fed^{-1}) in both growing seasons, respectively.

The data showed that fertilization treatments had, also, high significant effect on shoot yield in the two growing seasons and the highest mean values were obtained by F_2 treatment (18.78 and 21.48 ton fed^{-1}, respectively). On the contrary, the lowest mean values were recorded with F_5 (8.43 and 9.32 ton fed^{-1}, respectively). These results are a in agreement with those reported by MarinKovic *et al*, (2010) and Moursi and Darwesh, (2014).

3. Sugar percentage and Sugar yield: It can be observed clearly from Table (12) that the irrigation cut-off treatments had a high significant effect on sugar yield and its quality. The highest values of sugar yield in the 1st and 2nd growing seasons were achieved with I_3 treatment (3.59 and 3.83 ton fed^{-1}, respectively), while I_4 recorded the highest sugar % (20.5 and 19.8 %, respectively).

Also, the fertilization treatments had a high significant effect on both parameters in both growing seasons. In both seasons, F_2 treatment achieved the highest values of sugar yield (3.73 and 4.12 ton fed^{-1}, respectively) and sugar % (19.8 and 20.0 %, respectively). On the other hand, F_5 treatment in both seasons recorded the lowest sugar yields (2.86 and 3.30 ton fed^{-1}, respectively) and sugar % (18.1and 18.0 %, respectively). These results are in a great harmony with those obtained by MarinKovic *et al*, (2010) and by Moursi and Darwesh, (2014).

CONCLUSION

The results obtained from the present study indicated that the highest values of water applied, water consumptive use and water stored were recorded with the control (cut-off at 100 % of furrow length), while the lowest values of these parameters were recorded with cut-off at 70 % of furrow length. The highest values of water saving, irrigation application efficiency (E_a) and consumptive use efficiency were recorded with cut-off at 70 % of furrow length. Also, the highest values of water productivity (WP) and productivity of irrigation water (IWP) were recorded with cut off of irrigation at 80 % of furrow length, while the lowest values were recorded with the control.

Concerning the role of fertilization, application of 67.5 kg N fed^{-1} with 3 ton compost fed^{-1} achieved the highest values of WP and IWP, while application of 22.5 kg N fed^{-1} with 7 ton compost fed^{-1} gave the lowest values.

The highest reduction of EC_e, SAR and ESP were induced by the interaction between 10 ton compost fed^{-1} with check irrigation treatment, while the lowest reductions were recorded with 90 kg N fed^{-1} and irrigation cut-off at 70 % of furrow length.

In general, the highest significant effects on sugar beet yield were achieved by the interaction between irrigation cut-off at 80 % of furrow length and application of 10 ton compost fed^{-1}.

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REFERENCES

Abdel-Fattah, M.K. (2012). Role of gypsum and compost in reclaiming saline-sodic soils. ISSN, 2319-2380, ISBN, 2319-2372; 1 (3):30-38.

Abou El-Magd, M.M., Hoda, M.A. and Fawzy, Z.F. (2005). Relationships, growth, yield of broccoli with increasing N, P or K ratio in a mixture of NPK fertilizers. Annals of Agricultural Science; 43 (2): 791-805.

Abu-Zahra, T.R. and Tahboub, A.B. (2008). Effect of organic matter sources on chemical properties of the soil and yield of strawberry under organic farming conditions. World Applied Sciences Journal 5 (3): 383-388. ISSN 1818-4952.

Adugna, G. (2016). A review on impact of compost on soil properties, water use and crop productivity. Academic Research J. of Agric. Science and Research, 4(3): 93-104.

Aiad, M.A.; Moursi, E.A.; El-Dissoky, R.A. and Amer, M.M. (2014). Response of maize crop to irrigation under different rates and doses of nitrogen fertilization in the North Nile Delta Region. J. soil Sci. and Agric. Eng, Mansura Univ., 5 (10:97-113.

Ali MH, Hoque MR, Hassann AA, and Khair A. (2007). Effect of deficit irrigation on yield water productivity, and economic returns of wheat. Agric. Water Management; 92(3):151-161.

Black, G.R amd Hartge, K.H. (1986). Bulk density, In; A.klute, *et al.* , Eds. , Methods of soil Analysis, part 1 , ASA and SSSA , Madison ,: 363-375.

Blumenthal, J.M. (2001). Fertilizing sugarbeet. In: R.G. Wilson, editor, Sugarbeet production guide. Univ. of Nebraska Coop. Ext. Bull. EC01-156. Nebraska, Lincoln, NE: 75-80.

Bower, C.A.; Reitmier, R.F. and Fireman, M. (1952). Exchangeable cation analysis of saline and alkali soils. Soil Sci., 73:251-261.

Cai, B. and Ge, J. (2004). The effect of nitrogen level on main nutrient of sugar beet. Nature and Science, 2(4):79-83.

Carter, M. R., Sanderson, J. B. and MacLeod, J. A. (2004). Influence of compost on the physical properties and organic matter fractions of a fine sandy loam throughout the cycle of a potato rotation. Can. J. Soil Sci. 84: 211-218.

Chaudhary, O.P.; Josan, A.S.; Bajwa, M.S. and Kapurb, M.L. (2004). Effect of sustained sodic and saline-sodic irrigation and application of gypsum and farmyard manure on yield and quality of sugar cane under semi-arid conditions. Field Crops Res., 87(2-3):103-116.

Cooke, D.A. and Scott, R.K. (1993)."The Sugar Beet Crop". Chapman and Hall London: 262-265.

Coyne, M.S. (2008). Biological denitrification. In Nitrogen in agricultural systems, ed. J.S. Schepers and W.R. Raun, 201–254. American Society of Agronomy monograph no. 49.

Diacono, M., and Montemurro, F.. (2010). Long-term effects of organic amendments on soil fertility: A review. Agron. Sustain. Develop. 30:401-422. doi:10.1051/agro/2009040.

Doorenbos, J. and Pruitt, W. O. (1975). Crop water requirements. FAO Irrigation and drainage Paper, No. 24 Rome.

Downy, LA. (1970). Water use by maize at three plant densities. Paper, 33, FAO, Rome.

El-Hadidi, E. M.; Saied, M.M., Ghaly, Fatma, M. and Khalifa, R.M. (2016). Assessing the effect of water discharge rates and cut-off irrigation on wheat production and some water relations in North Nile Delta region. J. Soil Sci. and Agric. Eng, Mansura Univ., 7 (6): 397-407.

El-Hassanin, S.M.R., Moustafa, N.S., Khalifa, A.M. and Ibrahim, N.I. (2016) Effect of foliar application with humic acid substance under nitrogen fertilization levels on quality and yields of sugar beet plant. Int. J. Curr. Microbiol. App. Sci. 5(11): 668-680.

El-Ramady, H.R.; Amer, M.R; and Aiad, M.A. (2013). Sustainable water and nutrient management; use land leveling, cut-off irrigation and N-fertilizer in wheat production. J. of Applied Sci. Res., 9 (3):2232-2243.

FAO and IIASA. (2000). Diagnosis and improvement of saline and alkali soils, USDA handbook No, 60.

Garcia, G. (1978). Soil Water Engineering Laboratory Manual. Colorado State Univ. Dept. of Agric. and chemical engineering. Fort Collins, Colorado, 80523.

Gharaibeh, M.A.; Eltaif, N.I. and Albalasmeh, N.N. (2011). Reclamation of highly calcareous saline sodic soils using Atriplexhalimus and by-product gypsum. Int. J. Phytorem, 13: 873-883.

Gomez, K. A. and Gomez, A. A. (1984). "Statistical Procedures for Agricultural Research". 2nd ed. John Willey and sons Pub. PP. 139-153.

Hansen V.W., Israelsen O.W., and Stringharm Q.E. (1979). Irrigation principles and practices, 4th ed. John Willey and Sons, New York; 1979.

Hergert, G.W. (2010). Sugar beet fertilization. Sugar Technol., 12:256-266. Doi: 10.1007/s12355-010-0037-1.

Hussein, M.M. and Siam, H.S. (2012). Growth, Yield and Water Use Efficiency of Fodder Beet Responses to the NPK Fertilizer and Withholding Irrigation. International Journal of Science and Research (IJSR), ISSN (Online): 2319-7064. Impact Factor (2012): 3.358.

Ibrahim, M. A. M. and Emara, T. K. (2009). Beet Cut-Off Irrigation as Effective Way IN Water Saving. Thirteenth Inter. Water Tech. Conf., IWTC13 2009, Hurghada, Egypt.

Javaheri, M.A., Rashid, N., and Baghizadeh, A. (2005). Influence of organic farmyard manure, potassium and boron on quantity and quality of sugar beet in Bardsir region, J. Sugar Beet (Iran), 21: 31-41.

James, L. G. (1988). Principles of farm irrigation system design. John Willey/Sons (ed.), New York, pp. 543

Kaffka, S.R., Peterson, G.R. and Kirb, D. (1998). Earlier irrigation cutoff for sugar beet conserves water. California Agriculture, 52 (1): 21-24.

Kassab, M.M. (2012). Maize water parameters under cut-off irrigation. Minufiya J. Agric. Res., 37 (6): 1529-1539.

Kassab, M.M and Ibrahim, M.A.M. (2007). Cut off Wheat (triticum Sp.) Irrigation as an Effective Technique for Improving Water Management. Alex. Sci. Exchange J., 28 (4).

Khalifa, R.M. (2013).Water requirements of maize and sugar beet crops as affected by soil moisture depletion and water table level .M.Sc. Thesis, Fac.of Agric .Kafr el-sheikh Univ., Egypt.

Kirda C. (2002). Deficit irrigation practices: Deficit irrigation scheduling based on plant growth stages showing water stress tolerance. FAO.

Leaon, M. (1995). Adapted from organic materials management, Californial integrated Waste management Board.

Lehrsch, G. A., Brown, B., Lentz, R. D., Johnson-Maynard, J. L., and Leytem, A. B. (2015a). Sugarbeet Yield and Quality When Substituting Compost or Manure for Conventional Nitrogen Fertilizer. Agronomy Journal, 107, Issue (1).

Lehrsch, G. A., Brown, B., Lentz, R. D., Johnson-Maynard, J. L., and Leytem, A. B. (2015b). Compost and Manure Effects on Sugarbeet Nitrogen Uptake, Nitrogen Recovery, and Nitrogen Use Efficiency. Agron. J., 107, Issue (3).

Lentz, R.D., and Lehrsch, G.A.. (2012). Nitrogen availability and uptake by sugar-beet in years following a manure application. Int. J. Agron. Vol. 2012, Article ID 120429. doi:10.1155/2012/120429.

Lentz, R.D., and Lehrsch, G.A. (2014). Manure and fertilizer effects on carbon balance and organic and inorganic carbon losses for an irrigated corn field. Soil Sci. Soc. Am. J. 78: 987-1002. Doi: 10.2136/sssaj, 07.0261.

Loper, S., Shober, A.L., Wiese, C., Denny, G.C., and Stanley, C.D. (2010). Organic soil amendment and tillage affect soil quality and plant performance in simulated residential landscapes. HORTSCIENCE, 45(10):1522-1528.

Madejon, E.; Lopes, R. ; Murillo, Y.M. and Cabrera, F. (2001). Agricultural use of three sugar beet vinasses compost: effect of crops and chemical properties of a cambisol soil in the Quadalguivirm River Valley (Spain). Agric. Ecosystems and Environ., 84:55-65.

Mahmoud, E.A., Ramadan, B.S.H., El-Geddawy, I. H. and Korany, S.F. (2014) Effect of mineral bio-fertilization on productivity of sugar beet. J. Plant Production, Mansoura Univ. 5(4):699-710.

Marinkovic BJ, Crnobarac G, Jacimovic M, Rajic D, Latkovic V A. (2010). Sugar yield and technological quality of sugar beet at different levels of nitrogen fertilization. Research Journal of Agricultural Science 42(1): 162-167.

Masri, M.I., Ramadan, B.S.B., El-Shafai, A.M.A. and El-Kady, M.S. (2015) Effect of water stress and fertilization on yield and quality of sugar beet under drip and sprinkler irrigation systems in sandy soil. Int. J. Agric. Sci. 5(3), 414-425.

Mehrandish,M., Moeini, M.J. and Armin, M. (2012). Sugar beet (Beta vulgaris L.) response to potassium application under full and deficit irrigation. European Journal of Experimental Biology, 2012, 2 (6):2113-2119.

Michael, A.M. (1978). Irrigation theory and practice. Vikas Publishing House, New Delhi, 1978.

Mirzaei M.R,and Rezvani MA (2007). Effects of water deficit on quality of sugar beet at different growth stages. Sugar beet J, 23(1)29-42.

Mohamed S. Abbas, Amira S.H. Soliman, Zeinab R. Moustafa and Kenawy M. (2018). Effect of some soil amendments on yield and quality traits of sugar beet (Beta vulgaris L.) under water stress in sandy soil. Egypt.J.Agron, 40, (1): 75- 88.

Mostafazadeh, B. and Farzamnia, M. (2000). The study of hydraulic performance of furrow irrigation under different methods of discharge management. J. of Sci. and Technology of Agric. and Natural Resources. 4: 3, 1-11.

Mosalm, W.M (2009). Evaluation of surface irrigation under different rates of water discharge and nitrogen fertilization levels. . Ph. D. Thesis, Fac. Agric. Mansoura Univ. Egypt.

Moursi, E.A. and Darwesh, R. Kh. (2014). Effect of irrigation and nitrogen fertilization on sugar beet yield, quality and some water relations in heavy clay soils. Alex. Sci. Exchange J., 35 (3).

Mubarak, M.U., Zahir, M., and AbdulWakeel, A.S. (2016).Sugar beet yield and industrial sugar contents improved by potassium fertilization under scarce and adequate moisture conditions. Journal of Integrative Agriculture, 15 (11): 2620-2626.

Mustafa, M.E. (2007). Effect of Nitrogen and Phosphorus Fertilization on The Performance of Three Sugarbeet (Beta vulgaris.L) Cultivars. Master of Science (Agric.) Department of Agronomy, Faculty of Agriculture, University of Khartoum.

Page, A.L., Miller, R.H. and Keeney, D.R. (Eds.), (1982). Methods of soil analysis. Part 2, Chemical and mineralogical properties. Agronomy Series No. 9. American Society of Agronomy, Madison, WI.

Piper, C. S. (1950).Soil and Plant analysis. Inter. Science Puplication. New York, Reddy, B.V.S.;Reddy, ps., Bidinger, F.

Richard, R.L. (1954).Diagnosis and improvement of saline and alkali soils. USDA agriculture Handbook, No 60, US Gov. Printing Office, Washington.

Saffarian Toosi, M.J., Esmaeili AM, Mohamadian R and Amini, I. (2006). Effects of irrigation time before harvest on the quantitative and qualitative traits of two sugar beet cultivars in Mashhad. Journal of Sugar Beet., 22 (1): 13-23.

Sharma, A.R. and Mittra, B.N. (1991). Effect of different rates of application of organic and nitrogen fertilizers in a rice-based cropping system. J. of Agricultural Sci., 117: 313-318.

Sohrabi, Y. and Heidari, G. (2008). Influence of Withholding Irrigation and Harvest Times on Yield and Quality of Sugar Beet (Beta vulgaris). International Journal of Agriculture & Biology Issn Print: 1560–8530; ISSN Online: 1814-9596 07-445/MFA, 10 (4): 427-431.

Suja, G. and Sreekumar, J. (2014) Implications of organic management on yield, tuber quality and soil health in yams in the humid tropics. Int. J. Plant Prod. 8 (3): 291-310.

Sundhari, T.;Thilagavathi, T. ; Baskar, M. ;Thamarai Thuvasan and Eazhilkrishna, N. (2018). Effect of gypsum incubated organics used as an amendment for sodic soil in green-gram. International Journal of Chemical Studies, 6 (1):304-308.

Talenghani, D.F., Hemayati, S.S., Noshad, H., Dehaghanshoar, M., Togidloo, G., and Hamdi, F. (2006). Effects of different manuring levels on some quantity and quality factors of sugar beet in wheat-sugar beet rotation, J. Sugar Beet (Iran), vol. 22, pp. 67-68.

Valarini,P.J., Curaqueo,G., Segue,A., Manzano, K., Rubio,R., Cornejo,P., and Borie, F.(2009). Effect of compost application on some properties of a Volcanic Soil from Central South Chile. Chilean Journal of Agricultural Research 69 (3):416-425.

Wallace, P. and Carter, C. (2007) Effects of compost on yields of winter wheat and barley, sugar beet, onion and swede in the fourth and fifth years of a rotation. Home Growth Cereals Authority Project Report. 422, 31pp.

Yonts,C.D., Palm, K.L. and Reichert, D.L. (2003). Late Season Irrigation Management for Optimum Sugarbeet Production. Journal of Sugar Beet Research, 40 (1-2).

تحسين الإنتاجية الأرضية والمائية لمحصول بنجر السكر تحت ظروف الأراضى المتأثرة بألأملاح في منطقة دلتا نهر النيل-مصر

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تم إجراء تجربتين حقليتين خلال موسمي نمو متواليين لموسمى 2017/2016 و 2018/2017 في مزرعة محطة البحوث الزراعية بسخا ، محافظة كفر الشيخ . وكان الهدف من هذه الدراسة هو تقييم تأثير أربع معاملات لايقاف سريان مياة الري عند 100٪ (I_1)، 90٪ (I_2) ، 80 (I_3) ، 70٪ (I_4) من طول الخط وخمسة معاملات تسميد : F_1 (90 كجم نيتروجين/فدان)، F_2 (سماد 67.5 كجم نيتروجين و3 طن كومبوست/فدان) , F_3 (45 كجم نيتروجين و5 طن كومبوست /فدان)، F_4 (22.5 كجم نيتروجين و7 طن كومبوست /فدان) ، F_5 (10 طن كومبوست/فدان) على انتاجية مياة الرى وبعض خصائص التربة والعائد من بنجر السكر. تم تصميم التجارب فى شرائح متعامدة بثلاثة مكررات حيث كانت الشرائح الرئيسية تمثل معاملات ايقاف سريان مياة الرى ، بينما الشرائح الشقية تمثل معدلات التسميد. ويمكن تلخيص النتائج على النحو التالي • : تحصل على أعلى القيم للمياه المضافة (3678 و 3562 م3/فدان) ؛ والاستهلاك المائى (2381 و2210 م3/فدان) و الماء المخزن (2525 و 2456 م3/فدان) مع المعاملة I_1 في موسمي النمو على التوالي. وكانت أقل قيم للمياه المضافة (3168 و 3094 م3/فدان) , والاستهلاك المائى (2218 و 2062 م3/فدان) والماء المخزن (2325 و 2335 م3/فدان) مع المعاملة I_4 في موسمي النمو على التوالي • .تم تسجيل أعلى قيم لتوفير مياه الرى مع I_4 كمتوسط لموسمى النمو (12.14 و 11.14 سم ، على التوالي) مقارنة مع(I_1 ايقاف المياة عند 100% من طول الخط) . •سجلت أعلى القيم لكفاءة الأضافة لمياة الري في كلا الموسمين مع I_4 (73.39 و 75.47٪ على التوالي) ، بينما سجلت أقل القيم (68.7 و 69.0٪ على التوالي) مع I_1 • . تم الحصول على أعلى القيم لكفاءة الماء الاستهلاكي (70.0 و 66.7٪) مع I_4 ، ولكن تم تسجيل أقل القيم (64.7 و62.0٪) مع I_1 في الموسم الأول والثاني على التوالي • .فيما يتعلق بإنتاجية المياه (WP) وإنتاجية مياه الري (IWP) ، تم تسجيل أعلى القيم WP (16.74,14.09 كج/م3) و IWP (9.70 , 11.61 ، 9.70 كج/م3) مع I_3 في الموسمين الأول والثاني ، على التوالي . من ناحية أخرى ، سجلت أقل قيم WP (12.16 ،14.99 كجم/م 3) وIWP (7.88 ،9.30 كجم/م 3) مع I_1 في كلا الموسمين ، على التوالي • .فيما يتعلق بتأثير التسميد على WP و IWP ، حققت المعاملة F_2 أعلى قيم WP (11.23 و9.19 كجم/م3) و WI (9.19 و 11.23كجم/م3) ، بينما أعطيت المعاملة F_4 أقل القيم لكل منهما في كلا الموسمين ، على التوالي • تأثرت قيم EC_e و SAR و ESP للتربة لكلا الموسمين بمعاملات الري والتسميد. تم تحقيق أعلى انخفاض فى EC_e و SAR و ESP بواسطة التفاعل بين F_5 مع I_1 ، بينما تم تسجيل أقل انخفاض مع التفاعل بين F_1 و I_4 . •تم تحقيق أعلى تأثير معنوي لمعاملات الرى والتسميد على محصول الجذور ، والعرش والسكر لبنجر السكر في كلا الموسمين مع I_3 و F_5 . وتم تحقيق أعلى إنتاجية للجذور (18.78 و 20.61/فدان) مع I_3 ، بينما كان F_5 أفضل معاملة تسميد (15.76 و 18.13 طن جذور/فدان) في كلا الموسمين ، على التوالي . أيضا ، كانت هناك تآثير عالي المعنوية نتيجة للتفاعل بين المعاملات المختلفة على محصول البنجر.