J. Agric. Sci. Mansoura Univ., 34 (6): 7467 - 7480, 2009

SUGAR BEET PRODUCTION UNDER DRIP IRRIGATION IN HEAVY CLAY SOIL

Khalifa, E. M.[1] and M. E. Meleha[2]
1-Ag. Eng. Dept., Fac. of Agric., Kafrelsheikh Univ., Egypt.
2-Water Management Research Institute, National Center of Water Research, Shubra, Egypt.

ABSTRACT

Sugarbeet is an important crop in Egypt where overuse of water and agro chemicals is a concern in furrow-irrigated areas. Drip irrigation technology, is not well developed for row crops within the old land. Field experiment was carried out in the Experimental farm, Faculty of Agriculture Kaferelsheik University. Egypt, during the successive season 2005/2006.Therefore, the objective of the present work was evaluation of drip irrigation practice for sugar beet production in Delta region and its effect on soil salinity.

The present research includes the following factors:-

-Irrigation method : drip and furrow irrigation (main treatments);

- Irrigation intervals :Three irrigation intervals for drip, once, twice and triple per week, while the intervals for furrow irrigation was 18 days. (sub treatments), and
- Length of furrow and drip lines: Three different of furrow and drip lines were used in the present study (20; 30 and 40 m). (sub-sub treatments).

The experimental design was split-split plot with four replicates.

The important results that obtained from the present work were as follows:-

- The average value of total water applied was decreased by about of 1.01 and 0.47 % by using 20 and 30 m as a drip line length comparing with 40 m drip line length.
- There was no significant difference among the irrigation treatments on average values of root and sugar yield, Where there are no significant differences in the amount of water added to the unit area during the season.
- The highest value of water application efficiency was 91.63 % with drip irrigation, 20 m lateral length and once irrigation per week, while the lowest value was 69.10 % with furrow irrigation.
- Increasing number of irrigation per week tended to increase field water use efficiency which the values of field water efficiency were 10.83, 9.73 and 9.12 Kg/m^3 by using drip irrigation triple, twice and once per week, respectively.
- The increasing values of soil salinity were 0.11, 0.20 and 0.26 dsm-1 for irrigation intervals: triple, twice and once per week, respectively. it could be concluded that the salt accumulation in the root zone can be easily leached by increasing more amounts of irrigation water before the start of the next season.

INTRODUCTION

Drip irrigation is the frequent application of water either directly into the soil surface or into the root zone of the crop to maintain the soil water content near the plant roots at optimum level. Irrigating only apportion of soil surface, limits evaporation, reduce weed growth and minimizes the underground water level which causes many problems. Using drip irrigation system on a large scale will help in saving huge amount of irrigation water which in turn can be used to cultivate more land. Sugar beets are most commonly irrigated by the furrow irrigation method, specially in the north of Delta Egypt. But drip irrigation is used where topography, high water table, or other special conditions make the furrow system difficult to use. Drip irrigation, though more costly, has advantages in improving seedling emergence and in using less water in the early stages of plant growth.

Doorenbos and Kassam (1986) indicated that the water requirements of sugar beet ranged from 550 to 770 mm/season. Moreover, they added that irrigation increased yield but decreased sugar content. *Bader (1987)* found that the total water applied for sugar beet in Nubaria sandy soil was 5271 m^3/fed under furrow irrigation and 3364 m^3/fed with sprinkler irrigation. He also, found that water application efficiency (WAE) values in sandy soil were 49.8% with furrow irrigation and 81.2% with sprinkler irrigation. *El-Gindy (1988)* showed that drip irrigation led to save 50 % of irrigation water and the total yield increased by about of 32 and 52.6 % for cucumber compared with furrow and sprinkler irrigation, respectively in silt loam soil. *Amaducci et al. (1989)* studied the sugar beet yield response to irrigation in Southern and Northern Italy. According to their study, irrigation decreased the sugar content and increased the root mass resulting to the increase of the total sugar yield. *Ayars et al., 1990* mentioned that wheat, barley and sugar beet are produced during the winter when evaporative demand is low. Salts in soils and water acts as a water stress factor by reducing the amount of available water in the profile. The adverse effects of salt on crops growing during the winter period is less, because crop water requirements are much less. *Roth et al., (1995)* reported that, improved agronomic use efficiencies and yields and lower contamination with drip irrigation for production of vegetables, fruits, cotton (*Gossypium hirsutum L*.), and sugar beet. *Abou-Sheishaa (2001)* mentioned that, sugar beet is characterized by short growing season, consumes less water than cane (about two-thirds) and it may also grows under a wide varieties of soil and climatic conditions. *Cassel sharmasarkar et al., (2001)* showed that the use of drip irrigation, in lieu of furrow practices, was effective for reducing water and fertilizer use while sustaining sugar beet productivity. However, drip irrigation technology has not been well established in the Rocky Mountain area, particularly for row crops such as sugar beet. Furthermore, there is a paucity of data on the economic feasibility of drip-irrigated sugar beet production in this region. *K.ksal et al.(2001)* mentioned that common irrigation methods practiced for sugar beet production are wild flooding, furrow and basin. In general, farmers over irrigate, resulting in high losses of water and low irrigation efficiencies, and thus creating drainage and salinity problems. The highest benefit per unit of applied water depends upon the effective use of water by preventing water losses. These can partly be prevented by using new irrigation techniques and by reduction of evapotranspiration. New irrigation techniques are the cutback furrow, surge furrow, and alternate furrow in surface irrigation, and the use of very precise techniques in pressured irrigation. Evapotranspiration can be reduced either by agricultural practices such as tillage and mulching or by changing irrigation programs. The reduction of evapotranspiration by changing irrigation programs can be managed by the application of deficit irrigation. *Ertek et al., (2002)* mentioned that, it is necessary to get maximum yield in agriculture by using available water in order to get maximum profit from unit area because existing agricultural land and irrigation water are rapidly diminishing due to the rapid industrialization and urban development. Therefore, it is necessary to know and supply the right amount of water needed for the plants, that is, plant water consumption. *Makrantonaki et al., (2002)* evaluated the surface and subsurface drip irrigation (SDI) application effects on sugar beet crop performance, under two levels (100% and 80%) of water application depth. They found that, irrigation method showed to affect crop performance significantly while water application level was less critical. The experimental results indicated that the subsurface drip irrigation leaded to a greater yield and higher sugar content making significant water saving compared to surface drip irrigation. *Awad et al (2003)* mentioned that the average water consumptive use during two successive growing seasons (1993 to 1995) for sugar beet yield at Elbostan (Nubaria Sector) was 2982 m^3/fed. and 3958 m^3/fed. for sprinkler and furrow irrigation, respectively. They added that sprinkler irrigation system resulted in higher root yield of 25.81 Mg/fed. compared to 20.94 Mg/fed. with furrow irrigation. *Metwally et al (2003)* studied the impact of farm irrigation management on the yield and water consumption of sugar beet. They found that the field water use efficiency was 0.012, 0.015 and 0.021 Mg/m^3 with strip, single and double furrows of irrigation methods, respectively under the LASER land leveling of 1.06 % slope. *Fabeiro et al (2003)* studied controlled deficit irrigation (CDI) in a sugar beet crop cultivated in a semi-arid zone. Eight drip irrigation treatments were differentiated by the level of fulfillment of the water requirements. The effect of deficit irrigation at three crop stages (vegetative development, root swelling and ripening) has been studied. Total productions and their industrial quality index (IQI) have proved to be not influenced by the total volume of irrigation water. On the other hand, as expected, highly significant differences do appear in connection with the water use efficiency (WUE) of the total volume received which has ranged from just over 130–170 kg ha^{-1} mm^{-1}. *Tawfik et al (2005)* studied the response of sugar beet crop (yield and quality) and attributed parameters to nitrogen fertilizer scheduling under different irrigation systems. Their results indicated that sprinkler irrigation system has maximum sugar beet crop yield and quality, as well as inhabited attributed growth parameters and rationalized water application. However, with respect to growth parameters, sprinkler irrigation system has improved both root diameter/length ratio; root weight per plant and root yield by about 11.91, 21.16 and 15.18 % comparing with modified furrow irrigation system, respectively.

The objective of the present study was evaluated of drip irrigation system for sugar beet production in clayey soil comparing with traditional irrigation method (furrow irrigation).

MATERIALS AND METHODS

Field experiment was conducted in the Experimental farm of Faculty of Agriculture, Kafr El-Sheikh. Tanta University. Egypt, during the successive season 2005/2006. Table (1) summarized some physical properties of the soil. Sugar beet cultivar *maribo marina poli* was used in the treatments.

Table (1): Some physical properties of the experiment soil.

Soil depth, cm	Particle size distribution, %				Bulk density, g/cm^3	F.C, %	W.P, %
	Clay	Silt	Sand	Soil texture			
0-15	53.80	22.30	23.90	Clayey	1.05	44.20	19.35
15-30	54.80	23.60	21.60	Clayey	1.20	43.23	18.79
30-45	52.10	27.70	20.20	Clayey	1.35	42.56	18.26
45-60	51.80	26.80	21.40	Clayey	1.33	40.73	17.68
60-75	52.70	24.60	22.70	Clayey	1.41	38.84	17.07

Irrigation requirements

Climatic data for the experimental site were collected from Sakha weather station. Evapotranspiration for sugar beet crop was calculated using CROPWATT computer program using climatic data. The input and output results were summarized in Table 2

Table 2: Climatic data and evapotranspiration for sugar beet crop during growing season.

Reference Evapotranspiration according to Penman-Monteith								
Country : Egypt			Meteo Station : Sakha – Kafrelsheikh					
Altitude : 6 m			Coordinates : 31.10 N.L.			30.90 E.L.		
Month	**Max. Temp. ºC**	**Min. Temp. ºC**	**Humid. %**	**Wind speed, km/day**	**Sunshine, hours**	**Solar radiation, $MJ/m^2/d$**	**Rain mm/d**	**ET_o, mm/d**
September	33.2	18.3	72.3	80.80	10.4	22.4	0.00	4.5
October	28.1	13.8	66.3	96.80	8.9	17.4	0.10	3.3
November	24.2	9.4	61.7	73.70	6.8	12.4	0.27	2.0
December	21.2	7.4	68.6	60.30	6.4	10.9	0.35	1.5
January	19.4	5.3	76.0	48.40	6.4	11.6	0.26	1.4
February	20.3	7.3	74.7	69.70	7.4	14.8	0.66	2.1
March	23.9	9.2	75.8	103.40	8.6	19.1	0.07	3.2
April	20.1	9.3	61.8	91.00	9.1	22.2	0.91	3.6
Average	23.8	10.0	69.6	78.00	8.0	16.3	0.33	2.7

Net irrigation Requirements (I_n):

Net irrigation requirements were calculated by using the following equation (*Ismail, 2002*).

$I_n = ET_c – (P_e + G_e + W_b)$

I_n = net irrigation requirements, mm/day.

P_e = effective rain (70 % from total precipitation), mm/day.

G_e = the contribution of ground water in water consumption (equal zero in the present study), mm/day.

W_b = the contribution of soil moisture stored in water consumption (equal zero in the present study),, mm/day.

ET_c = crop water requirements, mm/day. It was calculated from the following equation (*Ismail, 2002*) :-

$ET_c = K_c \mathbf{x} K_r \mathbf{x} ET_o$

K_c = crop factor (0.35, 1.20 and 0.70 for the initial stage; mid-season stage and late stage, respectively.

K_r = reduction factor (it is depending on distance between laterals, emitter discharge and soil texture (*Sakla, 1991*). Its value equal one in the present study).

ET_o = reference evapotranspiration, mm/day, which was calculated depending on climatic data.

Irrigation supply requirements (I_v):

It calculated from the following equation (*Ismail, 2002*).

$$I_v = \frac{I_n}{E_i(1 - LR)}$$

Where :-

I_v = irrigation supply requirements, mm/day.

E_i = irrigation efficiency (assumed 0.85 and 0.60 for drip irrigation and furrow irrigation, respectively).

LR = leaching requirements (assumed 0.10 from net irrigation requirements).

The present research includes the following Factors:-

1- Irrigation method

Two types of irrigation method was used (drip and furrow irrigation). The drip irrigation system consisted of main line from PVC 50 mm diameter; sub main line 25 mm diameter and lateral line made from PE 16 mm diameter. Built-in emitters (GR) were used with outlets spacing of 30 cm and 2 l h^{-1} flow rate.

2- Irrigation Scheduling:-

Irrigation scheduling is the decision of when and how much water to apply to a field. Its purpose is to maximize irrigation efficiencies by applying the exact amount of water needed to replenish the soil moisture to the desired level. Irrigation scheduling saves water and energy.

Three watering regimes were obtained by irrigating once, twice or triple weekly for drip irrigation. The operating time for drip irrigation system was calculated using the following equation;-

$$T = \frac{I_v * l * W * n}{q}$$

Where:-

T = operating time for drip irrigation, min./day

l = distance between emitter, m (0.30 m in the present study)

W = distance between rows, m (0.60 m in the present study).

n = number of emitter per plant (one in the present study).

q = emitter discharge, l/min.

In case of furrow irrigation, the irrigation intervals was calculated as follows (*Ismail, 2002*).:-

$$F = \frac{d_n}{I_n}$$

$$d_n = \frac{(FC - PWP)}{100} * \rho_d * d * 1000 * dep * P_w$$

Where :-

F = irrigation frequency (intervals), day

d_n = net application depth per irrigation, mm

FC = soil moisture content at field capacity, % (by weight)

PWP = soil moisture content at permanent wilting point, % (by weight)

ρ_d = soil bulk density.

d = soil root zone depth, m.

dep = allowable depletion (assumed 0.70 in the present work).

P_w = percentage wetted area (assumed 0.80 in case of furrow irrigation).

3- Length of furrow and drip lines:

Three different lengths of furrow and drip lines were used in the present study (20; 30 and 40 m).

The previous factors were affected on the following:-

1- Total applied water and water consumptive use.

Consumptive use of water by plants is defined as the unit amount of water used on a given area in transpiration, building of plant tissues, and evaporation from adjacent soil. Knowledge of consumptive use is necessary in planning farm irrigation and drainage systems, for improving irrigation practices, conserving energy, and assisting in irrigation scheduling. The soil moisture contents were determined gravimetrically at different soil layers. The depth of applied irrigation water for sugar beet under two irrigation systems was measured according to water consumed during irrigation intervals as the difference between soil moisture content at field capacity and the moisture content before next irrigation plus 10% as a leaching requirement. The depth of water to be applied and water consumptive use was calculated according to the equation given by Israelson and Hansen (1962) as follows:-

$$D_{aw} = \sum_{i=1}^{i=5} \left(\frac{F_c - \theta_1}{100} \right) * \rho_b * d$$

$$WCU = \sum_{i=1}^{i=5} \left(\frac{\theta_2 - \theta_1}{100} \right) * \rho_b * d$$

Where:

D_{aw} = depth of irrigation water to be applied, cm

WCU = water consumptive use, cm

i = number of soil layers

F_c = soil moisture content at field capacity, % (by weight)

θ_1 = soil moisture content before next irrigation, % (by weight)

θ_2 = soil moisture content after irrigation, % (by weight)

ρ_b = soil bulk density

d = soil root zone depth, cm

***2*- Root and sugar yield.**

3- Water application and distribution efficiency.

Proper timing of irrigation and application of the appropriate amount of water can maximize crop yield while minimizing water use. Excess crop water stress, resulting from inadequate irrigation, can reduce crop yield. Over-irrigation can also reduce crop yield and create more favorable conditions for disease development. The water application efficiency is the ratio of the average depth of irrigation water infiltrated and stored in the root zone to the average depth of irrigation applied water. It calculated by using the following equation *(Michael, 1978)*

$$E_a = \frac{W_s}{W_f} * 100$$

Where

E_a = Water application efficiency, %,

W_s= Water stored in plant root zone, cm, and

W_f= Water delivered to each treatment, cm.

The irrigation water that stored in the root zone was measured after 48 hours form irrigation. Many soil samples were take at different soil layers for many location among furrow length using auger and calculate the soil moisture content using gravimetric method.

Water distribution efficiency indicates the extent to which water is uniformly distributed along the field or the furrow. It was determined by using the following equation (*Michael, 1978*).

$$DE = \frac{(1 - y')}{d'} * 100$$

Where:-

DE = Water distribution efficiency, %,

d′ = Average depth of water stored along the furrow, cm, and

y′ = Average numerical deviation from d′, cm

***4* – Field water use efficiency.**

It is the weight of marketable crop produced per the volume unit of applied irrigation was expressed as cubic meters of water. It was calculated by the following equation (***Michael, 1978***).

$$FWUE = \frac{\text{Yield (kg/fed.)}}{\text{Water applied} (m^3/\text{fed.})}$$

5- Soil salinity .

Five replicates of soil samples were taken before planting and after harvesting to determine soil salinity by using the electrical conductivity meter

1:5 soil-water extract. In case of drip irrigation, four different locations from emitter of 0, 5, 10, and 15 cm at four different soil depths of 0, 15, 30, 45 cm. In case of furrow irrigation, the soil samples were taken at four different soil depths of 0, 15, 30, 45 cm.

RESULTS AND DISCUSSION

1- Total applied water and water consumptive use:

The average value of total water applied was decreased by about of 1.01 and 0.47 % by using 20 and 30 m as a drip line length comparing with 40 m drip line length whereas the average value of total applied water was 2511.22 m^3/fed./season with 40 m drip line length. The average values of total water applied were 2525.58, 2494.85 and 2476.04 m^3/fed./season for triple, twice and once irrigation per week, respectively.

It is clear that the values of total water consumptive use were affected by irrigation method, length of furrow, lines and irrigation intervals as the same manner of total applied water as shown in Table 3.

Table (3): Effect of irrigation method and irrigation intervals on total applied water and water consumptive use (m^3/fed.)

Irrigation method	Irrigation intervals per week	Furrow and drip line length, m		
		20	**30**	**40**
Drip	**Triple**	2501.76 (2090.80)*	2524.10 (2109.41)	2550.88 (1845.80)
	Twice	2486.64 (2077.60)	2496.15 (2073.15)	2501.75 (1800.97)
	Once	2468.99 (2043.11)	2478.10 (2013.07)	2481.04 (1777.57)
Surface irrigation (Furrow)		3225.6 (2123.95)	3312.52 (2166.37	3432.27 (2234.28)

*** values between practices indicates the total water consumptive use (m^3/fed).**

2- Root and sugar yield.

Crop production data are summarized in Figs. 1 and 2. There was no significant difference among the irrigation treatments on average value of root and sugar yield. The results indicated that the values of root and sugar yield that obtained with furrow irrigation method were 29.65 and 5.51 Mg/fed, respectively. Concerning the drip irrigation method, the values of root and sugar yield that obtained were 30.87 and 5.40 Mg/fed. using single lateral per plant row and once irrigation per week. Irrigation three time per week (irrigation interval) gave soil moist continuously, so the root took its need from the soil that reverberate on the productivity. The average values of root and sugar yield increased by about of 16.57 and 18.77 % in case of furrow irrigation compared with drip irrigation.

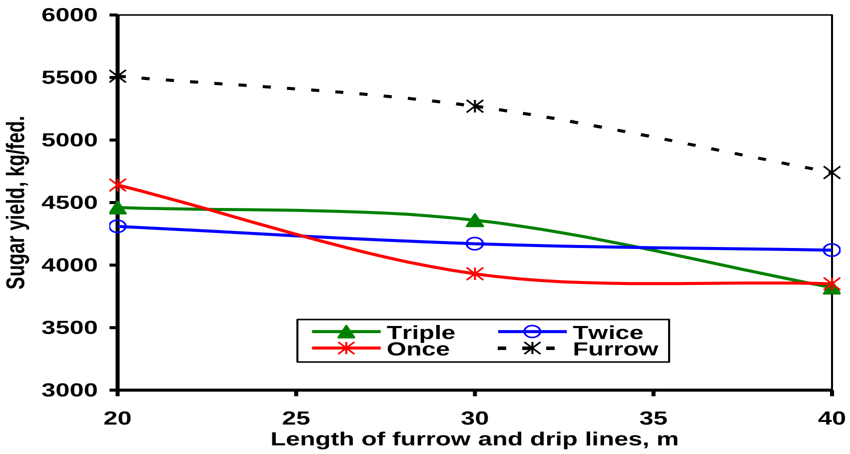

Fig. 1: Effect of furrow and drip line length and irrigation intervals on sugar yield.

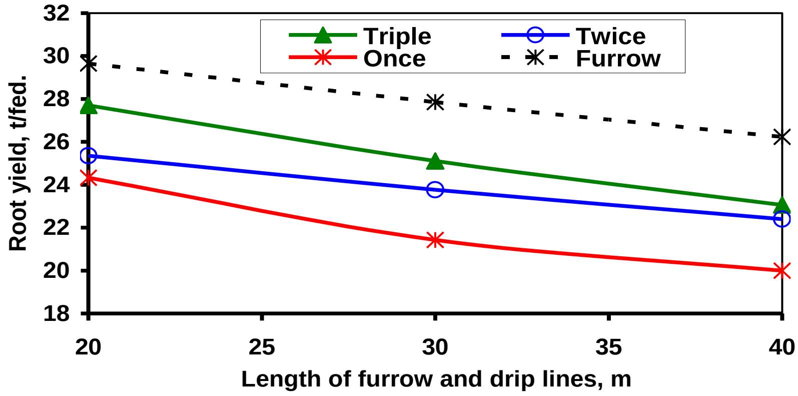

Fig. 2: Effect of furrow and drip line length and irrigation intervals on root yield.

3- Water application and distribution efficiencies.

Values of water application efficiency as affected by irrigation method, irrigation intervals and length of furrow and drip lines as shown in Fig. 3. The highest value of water application efficiency was 91.63 % with drip irrigation, 20 m lateral length and once irrigation per week, while the lowest value was 69.10 % with furrow irrigation. Concerning the length of lateral lines, the data revealed 40 m lateral length gave the best values of application efficiency comparing with the other treatments as shown in Fig. 3. Water distribution efficiency decreased by increasing length of furrow and drip lines as shown in Fig. 4. Drip irrigation method gave best values of water distribution comparing with furrow irrigation

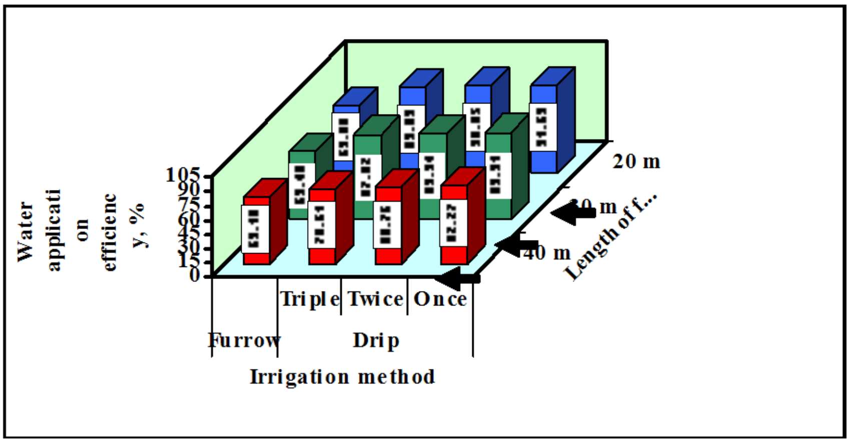

Fig. 3: Effect of irrigation method, irrigation intervals and length of furrow and drip lines on water application efficiency.

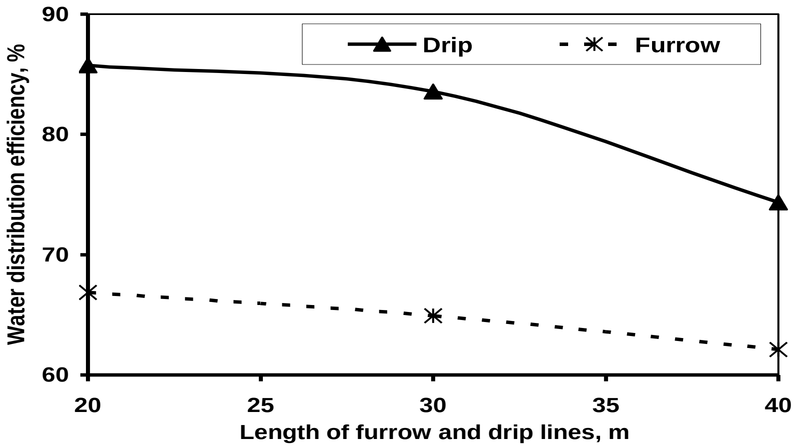

Fig. 4: Effect of irrigation method and length of furrow and drip lines on water distribution efficiency.

4 – Field water use efficiency.

Figure 5 shows the effect of different treatments on field water use efficiency. Results indicated that, the lowest value of field water use efficiency was 8.10 Kg/m^3 that obtained with drip irrigation method, 40 m lateral length and once irrigation per week. There was not significant effect of irrigation method on crop water use efficiency whereas the values of crop water use efficiency were 9.19 and 9.89 Kg/m^3 for furrow and drip irrigation methods, respectively. Generally, increasing number of irrigation per week tended to increase field water use efficiency which the values of field water efficiency were 10.83, 9.73 and 9.12 Kg/m^3 by using drip irrigation triple, twice and once per week, respectively.

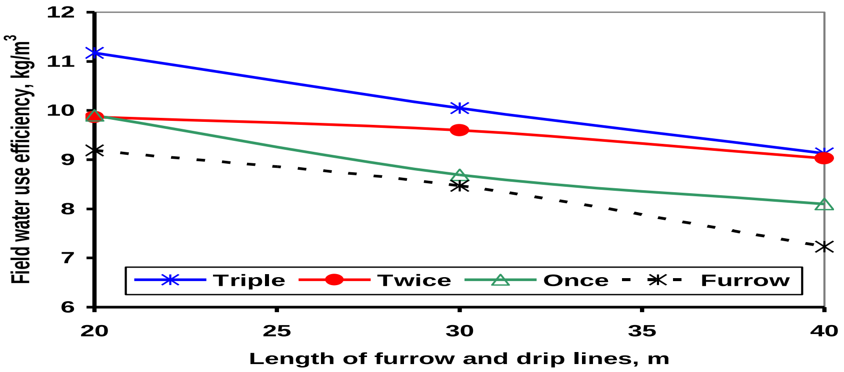

Fig. 5: Effect of furrow and drip line length and irrigation intervals on field water use efficiency.

7- Soil salinity.

Figure 6 indicates that, the total soluble salts as affected by the different treatments. Regarding the effect of irrigation method, it is clearly that furrow irrigation method resulted in reduction in soil salinity by about of 2.17 % due to vertical salt leaching, where as the values of soil salinity were 3.23 and 3.16 dsm^{-1} before planting and after harvesting, respectively. While the soil salinity increased in drip irrigation by about of 5.62 % before planting and after harvesting, respectively. The data showed that soil salinity increased at harvesting time in case of drip irrigation method because the salt accumulated in the root zone. Generally, it could be concluded that the salt accumulation in the root zone can be easily leached by increasing more amounts of irrigation water before the start of the next season. The increasing values of soil salinity were 0.11, 0.20 and 0.26 dsm^{-1} for irrigation intervals: once, twice and triple per week, respectively. The maximum value of soil salinity was 3.74 dsm^{-1} that obtained at 70 cm soil depth using drip irrigation method and interval irrigation once/week as shown in fig. 6.

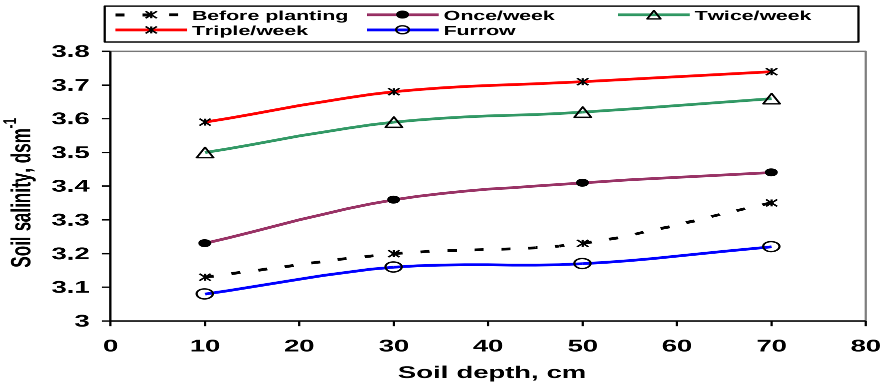

Fig. 6: Effect of furrow and drip irrigation method and irrigation intervals on soil salinity.

Conclusion

- The highest benefit per unit of applied water depends upon the effective use of water by preventing water losses. Drip irrigation is the frequent application of water either directly into the soil surface or into the root zone of the crop to maintain the soil water content near the plant root at optimum level. So, it decreases the loss from irrigation water by deep percolation than the surface drip irrigation.
-drip irrigation method gave the best values of saved irrigation water. It saved about of 723.84 m^3/fed./season and recorded the highest value of irrigation application efficiency.
- The salt accumulation in the root zone can be easily leached by increasing more amount of irrigation eater before start of the next season, where the farmers planting usually planting rice after sugar beet crop.

REFERENCES

Abou-Shieshaa, R.R. (2001). A study on mechanical topping of sugar beet under Egyptian conditions. Misr J. Ag. Eng., Egypt. 18(3):569-584

Amaducci, M.T.; C.G. De Caro; A. Gherbin; P. Mambelli and G. Venturi (1989). Sugar Beet Yield Response to Irrigation in Different Environmental Conditions, Irrigatione E Drainaggio, 36, 153-159.

Awad, M.A.; M.A. Mourad; K.I. Said and K.A. Allam (2003). Effect of sprinkler irrigation and nitrogen fertilization on sugar beet yield. The 11th Annual Conference of the Misr Society of Ag. Eng., Egypt.15-16 Oct.: 131-145.

Ayars, J.E., Hutmacher, R.B., Hoffman, G.J., Ben-Asher, J., and Solomon, K.H. (1990). Response of sugar beet to non-uniform irrigation. Irrig. Sci. Springer Berlin / Heidelberg, 11(2):101-109.

Bader, A. A. (1987). Sugarbeet production under sprinkler and furrow irrigation system (A compassion study). Misr J. Ag. Eng., Egypt. 4(4): 333-350.

Cassel Sharm asarkar, F.,S. Sharmasarkar, S.D. Miller, G.F. Vance and R.Zhang. (2001). Assessment of drip and flood irrigation on water and fertilizer use efficiencies for sugar beets. Agricultural Water Management. 46 (3). 241-251.

Doorenbos, J. and A.H. Kassam (1986). Yield response to water. FAO irrigation and Drainage Paper No. 33, Rome, Italy.

El-Gindy, A.M. (1988). Modern chemigation techniques for vegetable crop under Egyptian conditions. Misr J. Ag. Eng., Egypt. 5 (1): 99-111.

Ertek, A.; S. Sensoy; M. Yıldız and T. Kabay (2002). Estimation of the most suitable irrigation frequencies and quantities in eggplant grown in greenhouse condition by using free pan evaporation coefficient. K.S. Univ. Life Sci. Eng. J. (in Turkish), 5 (2), 57–67.

Fabeiro C; F. Mart´ın de Santa Olalla; R. López and A. Dom´ınguez (2003). Production and quality of the sugar beet (Beta vulgaris L.) cultivated under controlled deficit irrigation conditions in a semi-arid climate. Agricultural Water Management 62 (3): 215–227.

Israelsen, O.W. and Hansen, V.E. (1962). Irrigation principles and practices. 3rd Edit John Willey, cons. Inc. New, York.

Makrantonaki, M. S.; D. Kalfountzos and P. Vyrlas (2002). Water saving and yield increase of sugar beet with subsurface drip irrigation. Printed in Greece. All rights reserved, Global Nest: the Int. J. 4(2-3): 85 -91.

Metwally, M. A.; Z. M. Imara; M. E. Egela and N. M. Awad (2003). Impact of some leveling and irrigation systems on the yield and water consumptive use of sugar beet crop. The 11th Annual Conference of Misr Society of Ag. Eng., Egypt. 15-16 Oct., 20(4): 649-665.

Michael ,A.M. (1978). Irrigation theory and practice. 1st Edition New Delhi, pp: 546:603.

Roth, R.L., C.A. Sanchez, and B.R. Gardner (1995). Growth and yield of mature "Valencia" oranges converted to pressurized irrigation systems. Appl. Eng. Agric. American Society of Agricultural and Biological Engineers, 11(1):101–105.

Tawfik, S.F.; A.M. Zayton and M.A. El-Saadawy (2005). Sugar beet yields and crop coefficient as affected by nitrogen fertilizer application under different irrigation systems. Misr J. Ag. Eng., Egypt. 22(2): 513-531.

- إسماعيل س. م. (٢٠٠٢). تصميم و إدارة نظم الري الحقلي. الطبعة الأولى . توزيع منشأة المعارف بالإسكندرية. مصر.
- سكلا ش.ش. (١٩٩١) . هندسة الري و الصرف .الطبعة الأولى دار المعارف. مصر.

إنتاج محصول بنجر السكر تحت نظام الري بالتنقيط في الأراضي الطينية الثقيلة

السعيد محمد خليفة[١] و محمد إبراهيم مليحة[٢]
١ - قسم الهندسة الزراعية – كلية الزراعة – جامعة كفر الشيخ
٢ - معهد بحوث إدارة المياه – المركز القومي لبحوث المياه - شبرا

محصول بنجر السكر من المحاصيل الهامة لإنتاج السكر حيث انه يستهلك كميات كبيرة من مياه الري وان نظام الري الشائع استخدامه في ري هذا المحصول هو الري السطحي على خطوط. ونظرا للزيادة المستمرة في السكان ومحدودية الموارد المائية فأصبح من الضروري إتباع أساليب الري الحديثة في ري تلك المحاصيل لزيادة كفاءة استخدام مياه الري المتاحة. ويعتبر الري بالتنقيط من طرق الري ذو الكفاءة المرتفعة فقد استخدم في هذه الدراسة لإمكانية توفير كمية من مياه الري التي كانت تفقد من خلال الجريان السطحي أو الرشح العميق. ولقد أجريت التجارب الحقلية بمزرعة كلية الزراعة – جامعة كفر الشيخ خلال الموسم الزراعي ٢٠٠٥/ ٢٠٠٦ وذلك لتقييم الري بالتنقيط في إنتاج محصول بنجر السكر في منطقة الدلتا وتأثير ذلك على ملوحة التربة.

وقد اشتملت الدراسة على المعاملات التالية :-

١- المعاملات الرئيسية : طريقة الري :

واستخدمت في الدراسة طريقتين للري هما الري السطحي بالخطوط والري بالتنقيط.

٢- المعاملات الشقية : فترات الري :

استخدمت ثلاث فترات للري هي : الري مرة واحدة أسبوعيا – الري مرتان أسبوعيا – الري ثلاث مرات أسبوعيا).

١- المعاملات تحت الشقية : طول الخط :

تم استخدام ثلاث أطوال مختلفة للخطوط (الري السطحي) و ثلاثة أطوال للخطوط التوزيع للري بالتنقيط وكانت أطوال الخطوط ٢٠ – ٣٠ – ٤٠ متر.

واستخدم تصميم القطع المنشقة مرتين كتصميم إحصائي للتجربة مع أربع مكررات.وكانت أهم النتائج المتحصل عليها هي :-

- متوسط كميات مياه الري المضافة انخفضت بحوالي ١,١٠ ، ٠,٤٧% وذلك باستعمال أطوال خطوط ٢٠ ، ٣٠ متر مقارنة بالخطوط ذات أطوال ٤٠ متر.
- أظهرت النتائج أنه لا توجد أ ي فروق معنوية بين المعاملات على إنتاجية محصول الجذور وكذا إنتاج السكر.
- أوضحت النتائج أن أقصى قيمة لكفاءة إضافة مياه الري كانت ٩١,٦٣% تم الحصول عليها مع نظام الري بالتنقيط بأطوال خطوط ٢٠ متر و الري مرة واحدة أسبوعيا كفترات ري- بينما كانت اقل قيمة ٦٩,١٠% مع الري السطحي على خطوط.
- اتضح من التجارب انه بزيادة فترات الري أسبوعيا أدت إلى زيادة كفاءة استخدام مياه الري وكانت القيم المتحصل عليها هي ١٠,٨٣ ، ٩,٧٣ و ٩,١٢ كجم/متر٣ باستخدام الري بالتنقيط على فترات ري ثلاث مرات ري أسبوعيا ، مرتان ري أسبوعيا و ري مرة واحدة أسبوعيا على الترتيب.
- بزيادة فترات الري أدى إلى انخفاض ملوحة التربة نظرا لزيادة كمية مياه الري مع زيادة فترات الري.