EFFECT OF IRRIGATION DELIVERY SYSTEM AND PLANTING PATTERNS ON ROOT YIELD AND TECHNOLOGICAL QUALITY OF SUGAR BEET UNDER NORTH DELTA REGION CONDITIONS

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ABSTRACT

Two field experiments were carried out at North Delta region on farmer's field during 2005/06 and 2006/07 winter seasons to study the effect of two irrigation systems; i.e., improved and traditional mesqa and three planting pattern, i.e., ridges, platforms and rows on root yield and technological quality of sugar beet. The experimental design was a split-plot, with four replications, where the irrigation systems were allocated to the main plots and planting distributed were arranged in the sub-plots.

The results indicated that the improved mesqa irrigation system gave the highest values of root yield, gross and white sugar percentage and yields, while the traditional mesqa produced the lowest one. Also, the maximum field water use efficiency (FWUE) was recorded under improved mesqa techniques compared with traditional mesqa during the two seasons of study.

Beet sowing in platforms produced the highest values of root yield t/fed., gross and white sugar yield t/fed. and field water use efficiency (FWUE) in kg/m^3 of root and sugar yield, followed by ridges one, whereas, sowing in rows was at the end values.

It might be seen from data obtained that improved mesqa irrigation system saved water by 17.29 and 17.44%, whereas the sowing in platforms under improved irrigation system saved water by 20 and 19.12% in the first and second seasons, respectively.

INTRODUCTION

Sugar beet has become one of the major winter field crops in North Egypt due to its high income to the farmers. Sugar beet can be irrigated with about one/fourth the water utilized by sugar cane. In most places, it is grown as a summer crop, with irrigation if necessary, in dry climates. In some Mediterranean countries, it is grown as a winter crop and harvested in early summer. Under semiarid and arid climates, the agricultural production relies almost entirely on irrigation, it is a feature of traditional irrigation system that more water is added to the soil than is actually required to make up the deficiency in soil moisture which results from evapotranspiration. In addition to the excessive water, which drains through the root zone of the crop, water seeps from irrigation canals and water courses and, together, these can lead to a problem of water logging, especially when no adequate drainage system for water table control.

The improved management of water on the farm may conserve, either labor or soil and may increase yields of crops. In recent years, due to population pressures and demands for both increased quantity and better quality of food. Egypt must improve the agriculture efficiency to overcome the increasing population. Since water is the most riveting factor for plant production, it seems necessary to improve the irrigation management as a prerequisite to improve the water delivery system in the Nile Delta. Production and water relations of crops has been widely investigated by many researchers; Shams (2000), Meleha (2002), Ibrahim *et al.* (2003) and Mahmoud (2005). Also, plant population is a key factor influencing crop yield and quality. Results of many experiments on sugar beet and other field crops have been reported, which, either directly or indirectly suggested the importance of adequate light for optimum yield. Since sugar beet is usually produced under row culture, it seems reasonable to assume that variation in row and plant spacing will greatly influence solar radiation.

The present investigation was amid to study the effect of irrigation delivery system and plant pattern on root yield and technological quality of sugar beet.

MATERIALS AND METHODS

Two field experiments were carried out at North Delta district on farmer's fields, which were mainly different in irrigation systems during 2005/06 and 2006/07 growing seasons. Each experiment included one irrigation system and three planting methods (ridges, platforms and rows). In both experiments sugar beets were growing in large field plots. The sub-plot area was 180 m^2 (12 x 15 m). Each sub-plot included 24 ridges or rows spaced at 50 cm and hills at 20 cm. The optimum plant population (40000 plants/fed.) was used. The two experiments were laid out in a split-plot design with four replications. The main plots assigned to the two irrigation systems (improved and traditional mesqa), while, the sub-plot treatments were assigned to the three planting methods (ridges, platforms and rows).

Soil physical and chemical analyses were done for samples taken from 0-30 cm depth in the experimental sites before seedbed preparation and their data are presented in Table (1), according to methods of Jackson (1967). The experimental field was fertilized with 45 kg P_2O_5/fed. in the form of calcium superphophate (15.5% P_2O_5) and 36 kg K_2O/fed. in the form of potassium sulphate (48% K_2O) during soil preparation. Nitrogen with the rate of 100 kg N/fed., in the form of ammonium nitrate (33.5%N), was applied in two equal does; namely, the firs one after thinning and the second at 30 days later. The previous crop was rice in both fields and seasons.

Table (1): Some physical and chemical analyses of the experimental fields (average of two seasons) before sowing.

Irrigation systems	Physical analysis				Chemical analysis						
	Sandy (%)	Silt (%)	Clay (%)	Texture Class	EC-mmohs cm	pH	O.M. (%)	$CaCO_3$ (%)	F.C. (%)	W.P (%)	Soil saturation
Improved	23.20	22.30	53.10	Clay	3.89	8.70	1.60	1.50	41.81	24.60	82.09
Traditional	22.02	23.2	54.75	Clay	3.49	8.80	1.80	1.62	42.10	24.30	83.17

The commercial sugar beet cultivar Toro polygerm, was used in both seasons. Beet seeds were sown on 10/10/2005 and 15/10/2006 in hills at the rate of 3-4 seeds/hill. Hills were thinned at one plant/hill 35 days after sowing. Other cultural practices were down as recommended in sugar beet fields in the region.

Irrigation systems:

The field of irrigation system method was either an improved station, connected to pipe line mesqa, or a traditional pump connected to unimproved earthen mesqa. The amount of irrigation water applied was measured by using a cut-throat flume (20 x 90 cm) and was calculated in m^3/fed. (Early, 1975).

The collected data of the experiments involved the following criteria:

I. Irrigation:

1. Amount of water applied (m^3/fed.)
2. Irrigation time hours/fed.
3. Field water use efficiency.

The field water use efficiency was calculated as Michael (1978).

$$FWUE = Y/WR$$

Where:

FWUE = Field water use efficiency (kg/m^3)
Y = Root or white sugar yields (kg/fed.)
WR = Water delivered to the field (m^3/fed.)

II. Yield:

At maturity (200 days after sowing) a central area of 90 m^2 from each sub-plot was harvested at both experiments in the two seasons.

1. Root yield (t/fed.).
2. Gross sugar yield (t/fed.) = root yield (t/fed.) x gross sugar percentage.
3. White sugar yield (t/fed.) = Root yield (t/fed.) x white sugar percentage
4. Sugar losses yield (t/fed.) = Root yield (t/fed.) x loss sugar percentage.

III. Quality parameters:

All parameters were determined in the Delta Sugar Company limited laboratories at El-Hamoul, Kafr El-Sheikh Governorate according to the method of Le-Docte (1927), as described by McGinnus (1971). The parameters of quality include the following:

1. Gross sugar (%):

Juice sugar content was determined according to LeDocte (1927), as described by McGinnus (1971).

2. Extractable white sugar (%):

Corrected sugar content (white sugar) of beet was calculated according to Reinefeld *et al.* (1974), as described by Harvey and Dutton (1993).

3. Loss sugar (%) = Gross sugar (%) – White sugar (%).
4. Juice purity percentage.
5. Soluble non-sugars content:

   The soluble non-sugars (potassium, sodium and α-amino nitrogen in meq/100 g of beet) in roots were determined by means of an automatic sugar polarimetric.

Statistical analysis:

The analysis of variance was carried out according to Gomez and Gomez (1984). All means were compared by Duncan's Multiple Range Test (Duncan, 1955. Al statistical analyses were performed by using the analysis of variance technique b means of "IRRISTAT" computer package and L.S.D. test for interactions.

RESULTS AND DISCUSSION

Focusing light on the obtained results and trying to explain them are the aim of this study. Effect of irrigation systems and planting pattern as well as their interactions on root yield and technological quality are discussed, as follows:

I. Irrigation:

1. Amount of seasonal field water applied (m^3/fed.):

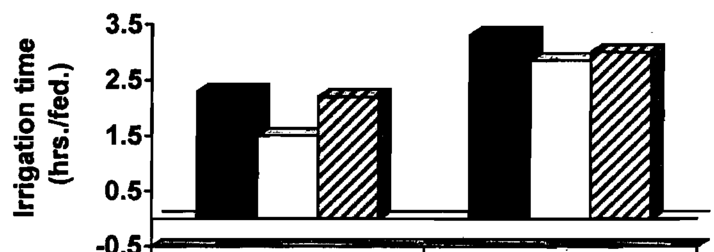
The total amount of irrigation water was measured and recorded, as shown in Table (2). It has been noticed that the traditional system, received the highest amount of irrigation water (2605.98 and 2633.10 m^3/fed.), while the improved irrigation system, utilized the least amount of irrigation water (2157.30 and 2175.08 m^3/fed.) in the two seasons, respectively. It can be seen from the data date that the improved mesqa irrigation system saved water by (17.22 and 17.39%) in the first and second seasons, respectively. Also, date clearly showed that the plant distribution in rows achieved the highest amount of irrigation water followed by sowing in ridges, while the platforms pattern recorded the lowest one (Table 2). The platforms saved water by 20.0 and 19.12% under improved irrigation system in both seasons, respectively.

Table (2): Amount field water applied (m^3/fed.) for sugar beet as affected by irrigation systems and planting pattern in the two seasons.

Planting pattern	Irrigation systems		Water saving (%)	Irrigation systems		Water saving (%)
	Improved mesqa	Traditional mesqa		Improved mesqa	Traditional mesqa	
	2005/06 season			2006/07 season		
Ridges	2106.50	2516.70	16.29	2225.20	2704.20	17.71
Platforms	1980.40	2475.50	20.00	2005.75	2480.10	19.12
Rows	2385.00	2825.75	15.59	2294.30	2715.00	15.49
Mean	2157.30	2605.98	17.22	2175.08	2633.10	17.39

2. Irrigation time hrs/fed.:

Data of irrigation time are illustrated in Fig (1). The average time of irrigation in the two seasons to sugar beet were 1.99 and 3.05 hrs./fed. under improved and traditional systems, respectively. While it was 1.50 hrs/fed. by sowing in platform under improved irrigation system. The results indicate that the traditional system and the planting in ridges and rows needed longer time for irrigation than the improved system and sowing in platform. The average value of time irrigation saving was 34.75% under improved system.



	Improved system	Traditional system
■ Ridge	2.29	3.3
□ Platform	1.5	2.85
▨ Row	2.2	3

Fig. (1): Irrigation time (hrs./fed.) for sugar beet as affected by irrigation systems and planting pattern (average of two seasons.

3. Field water use efficiency:

The term water use efficiency has been widely used in irrigation crop production to describe the irrigation with respect to crop yield. It is partiality important in comparing crop production from the stand point of water conservation and production cost.

Field water use efficiency (FWUE) are calculated and recorded in Tables (3 and 4). Data clearly showed that the improved systems recorded the highest values (20.80 and 20.31 kg/m^3) of root yield while the lowest values (15.62 and 10.29 kg/m^3) was obtained from traditional system in both seasons, respectively. These results be due to the minimum water applied in case of improved mesqa system. It is obvious that pipe line mesqa (improved mesqa) had the highest efficiency and the earthen mesqa (traditional mesqa) had the lowest one (Table 3).

The field water use efficiency was completely affected by each of irrigation systems and planting patterns. With regard to the effect of planting patterns on (FWUE) results showed that the platforms achieved the highest values (19.48 and 18.42 kg/m^3) of root yield followed by ridges one (18.59 and 16.08 kg/m^3), whereas, row pattern was at the end values being (15.82 and 15.60 kg/m^3) in both seasons, respectively (Table 3).

Field water applied, in relation to white sugar yield, (Table (4) illustrates that over the two averages in both seasons, were 2.84, 2.07, 2.27 and 1.77 kg/m^3 of white sugar for improved and traditional mesqa irrigation systems, respectively. In the present study, (FWUE) values indicated that, proportionately, higher yield of white sugar might be possible by the application of relatively low amounts of irrigation water. Similar observations were reported by Carter *et al.* (1975) and Last *et al.* (1983).

Concerning planting pattern, the same trend was obtained in relation to root yield. Values of 2.32, 2.53 and 2.09 kg/m^3 of white sugar results from ridges, platforms and rows pattern as a average of both seasons, respectively (Table 4).

II. Yield:

1. Root yield (t/fed.):

Data presented in Table (5) showed the effect of irrigation systems, planting patterns and their interactions on sugar beet root yield (t/fed.). It is clear from data listed in Table (5) that the irrigation systems effected significantly the beet root yield.

Table (3): Sugar beet field water use efficiency (FWUE) in kg/m^3 of root yield under irrigation systems and planting patterns in both seasons.

Irrigation system	Planting patterns									Average kg/m^3
	Ridges			Platforms			Rows			
	WR m^3	Y Kg/fed.	FWUE Kg/m^3	WR m^3	Y Kg/fed.	FWUE Kg/m^3	WR m^3	Y Kg/fed.	FWUE Kg/m^3	
	2005/06 season									
Improved mesqa	2106.5	44510	21.12	1980.4	44480	22.46	2385	44920	18.83	20.80
Traditional mesqa	2516.7	41450	16.46	2475.5	42360	17.11	2825.75	37560	13.29	15.62
Average kg/m^3	2311.6	42980	18.59	2227.95	43420	19.48	2605.37	41240	15.82	
	2006/07 season									
Improved mesqa	2225.2	42710	19.19	2005.75	45270	22.57	2294.3	44000	119.17	20.31
Traditional mesqa	2704.2	36580	13.52	2480.1	37370	15.06	2715.00	34190	12.59	10.29
Average kg/m^3	2464.7	39640	16.08	2242.92	41320	18.42	2504.75	39090	15.60	

WR = Seasonal water delivered to the field (m^3/fed.)

Y = Root yield (kg/fed.).

Table (4): Sugar beet water use efficiency (FWUE) in kg/m^3 of white sugar yield under irrigation system and planting patterns in both seasons.

Irrigation system	Planting patterns									Average kg/m^3
	Ridges			Platforms			Rows			
	WR m^3	Y Kg/fed.	FWUE Kg/m^3	WR m^3	Y Kg/fed.	FWUE Kg/m^3	WR m^3	Y Kg/fed.	FWUE Kg/m^3	
	2005/06 season									
Improved mesqa	2106.5	6200	2.94	1980.4	6020	3.03	2385	6150	2.57	2.84
Traditional mesqa	2516.7	5410	2.14	2475.5	5790	2.33	2825.75	4960	1.75	2.07
Average kg/m^3	2311.6	5800	2.50	2227.95	5900	2.64	2605.37	5550	2.13	
	2006/07 season									
Improved mesqa	2225.2	5640	2.53	2005.75	6150	3.06	2294.3	5910	2.57	2.27
Traditional mesqa	2704.2	4800	1.77	2480.1	4750	1.91	2715	4450	1.63	1.77
Average kg/m^3	2464.7	5220	2.15	2242.92	5450	2.42	2504.75	5180	2.06	

WR = Seasonal water delivered to the field (m^3/fed.)

Y = White sugar yield.

Table (5): Effect of irrigation systems, planting patterns and their interactions on root yield (t/fed.) at harvest in 2005/06 and 2006/07 seasons.

Irrigation systems	Planting patterns			Mean
	Ridges	Platforms	Rows	
		2005/06		
Improved mesqa	44.51	44.48	44.92	44.63 a
Traditional mesqa	41.45	42.36	37.56	40.45 b
Mean	42.98 a	43.42 a	41.24 b	
Interaction LSD (5%)	2.54			
		2006/07		
Improved mesqa	42.71	45.27	44.00	43.99 a
Traditional mesqa	36.58	37.37	34.19	36.04 b
Mean	39.64 b	41.32 a	39.09 b	
Interaction LSD (5%)	2.38			

Means designed by the same letter within the same row or column for each season are not significantly different at 5% level, according to Duncan's multiple range test and LSD test for interactions

The heaviest root yields (44.63 and 43.99 t/fed.) were obtained from improved mesqa followed by traditional mesqa (40.45 and 36.04 t/fed.) for the first and second seasons, respectively. Meaningful, improved mesqa irrigation surpassed the traditional mesqa in increasing beet root yield. The difference, in beet root yield between irrigation systems could be largely attributed to the amount of irrigation water, which was enough to meet the crop water need and availability of soil water in the effective root zone. Therefore, from the viewpoint of water management, there were improved mesqa irrigation systems to get the maximum beet root yield in the area of study. These results are in agreement with those obtained by Carter *et al.* (1975), Last *et al.* (1983), Azzazy (1998), Saied (2000), Abd El-Wahab *et al.* (2002) and Emara and Ibrahim (2004).

Significant beet root yield increases of about 5% during both seasons were achieved with platform patterns and it should therefore be regarded as a valid method of increasing beet root yields in North Delta areas. If, howevei, as suggested above, the differences are predominantly due to changes in partitioning arising from altered water use through the season (Table 5). These findings agree with those obtained by Lauer (1995), Angela and William (1996), Smit *et al.* (1996), Nemaeat Alla (1997) and Hilal (2000).

In both seasons sugar beet sowing in platforms under improved irrigation system had significantly greater root yields, than beet sowing in ridges or rows patterns (Table 5).

2. Gross sugar yield (t/fed.):

The most important single parameters which characterize yield and quality of sugar beet are: root, gross sugar, white sugar and loss sugar yield (t/fed.). Refined sugar production of sugar beet is based on the product of root yield and extractable sucrose concentration. Conditions that affect either of these components may either increase or decrease refined sugar yield.

Concerning the relation between gross sugar yield (t/fed.) and irrigation systems the data presented in Table (6) showed that the positive response in both seasons. Gross sugar yield was markedly higher (7.77 and 7.53 t/fed.) under improved mesqa irrigation, while, the lowest sugar yield (6.94 and 6.11 t/fed.) was recorded under traditional mesqa irrigation in both seasons, respectively. These results agree with those obtained by Carter *et al.* (1975), Last *et al.* (1983), Shams El-Din (2000), Saied (2000) and Meleha (2002).

In each of the 2 yr of the experiment, sugar beet grown in platforms pattern had significantly greater gross sugar yield than beet sowing in ridger or rows. The sugar yields in platforms, calculated as the product of root yield and gross sugar concentration, were 7.55 and 7.05 t/fed. in both seasons, respectively (significantly more than from beet sowing in ridges and rows). Similar results were found by Mahmoud *et al.* (1990), El-Khatib (1991), Angela and William (1996) and Hilal (2000).

The highest sugar yield produced from improved irrigation system with beet sowing in platform (7.73 and 7.79 t/fed.). The lowest one (6.43 and 5.79 t/fed.) resulted from traditional system and beet sowing in rows pattern.

3. White sugar yield t/fed.:

The white sugar yield is an important yield parameter of sugar beet because it is the final useful form of sugar that the consumer use. The mean values of extractable white sugar yield (t/fed.) at harvest as affected by irrigation systems and planting patterns are presented in Table 6.

In general, the trend of the effect of irrigation systems, planting patterns and their interactions on white sugar yield was similar to that of gross sugar yield and similar discussions could be cited (Table 6).

Table (6): Effect of irrigation systems, planting patterns and their interactions on gross, white and loss sugar yields (t/fed.) at harvest in 2005/06 and 2006/07 seasons.

Irrigation systems	Planting patterns											
	Gross sugar yield (t/fed.)				White sugar yield (t/fed.)				Loss sugar yield (t/fed.)			
	Ridges	Platforms	Rows	Mean	Ridges	Platforms	Rows	Mean	Ridges	Platforms	Rows	Mean
	2005/06 season											
Improved mesqa	7.73	7.73	7.86	7.77 a	6.20	6.02	6.15	6.12 a	1.73	1.65	1.57	1.65 a
Traditional mesqa	7.05	7.37	6.43	6.94 b	5.41	5.79	4.96	5.38 b	1.53	1.43	1.29	1.41 b
Mean	7.38 b	7.55 a	7.13 b	-	5.80 a	5.90 a	5.55 b	-	1.63 a	1.54 a	1.43 b	-
Interaction LSD 5%	0.94				0.66				0.40			
	2006/07 season											
Improved mesqa	7.33	7.79	7.48	7.53 a	5.64	6.15	5.91	5.96 a	1.55	1.55	1.56	1.55 a
Traditional mesqa	6.22	6.33	5.79	6.11 b	4.80	4.75	4.45	4.67 b	1.30	1.47	1.30	1.35 b
Mean	6.77 b	7.05 a	6.63 b	-	5.22 b	5.45 a	5.18 b	-	1.42 b	1.52 a	1.43 b	
Interaction LSD 5%	0.52				0.30				NS			

Means designated by the same letter within the same rows or column for each season are not significantly different at 5% level, according to Duncan's multiple range test and L.S.D. test for interactions.

4. Loss sugar yield (t/fed.):

The greatest sugar losses in the sugar factories results from the sugar in molasses, which is not crystallized. It is estimated by the major non-sugar components in the beet.

It could be noticed from the data presented in Table 6 that the differences between various irrigation systems and planting patterns were significant in both seasons. Concerning their effect on loss sugar yield where it ranged between 1.65, 1.41, 1.55 and 1.35 t/fed. for irrigation systems and between 1.63, 1.54, 1.43, 1.42, 1.52 and 1.43 t/fed. for ridges, platforms and rows patterns in both seasons, respectively (Table 6).

III. Quality parameters:

Beet quality is a combination of all the chemical and physical aspects of the beet root which influence processing or affect the yield of sugar and its by-products. It is desirable that beet should have a high sugar content and low contents of non-sugar components particularly sodium, potassium and α-amino-nitrogen. Thus the sugar extractability and its dependence upon the non-sugar i.e. the technical quality of sugar beet is determined by the relationship between sugar and the major non-sugar components.

1. Gross sugar percentage:

Sugar concentration as a percentage of fresh root is important because for a given weight of sugar produced by the crop, it is advantageous for it to be in roots of high sugar percentage. This not only reduces of haulage but increases its value to the grower in cash terms and to the processor in increased factory through-put. Irrigation usually decreased sugar percentage of early harvested roots because those from plots without irrigation contained less water (Last *et al.,* 1983).

Gross sugar percentage as affected by irrigation systems, planting patterns and their interactions are present in Table 7.

With regard to the effect of irrigation systems on gross sugar %, data show that the highest average values (17.42 and 17.13%) were obtained from improved mesqa technique, while the lowest values (17.18 and 16.97%) were recorded under traditional mesqa in both seasons, respectively.

Table (7): Effect of irrigation systems, planting patterns and their interactions on gross, white and loss sugar percentage at harvest in 2005/06 and 2006/07 seasons.

Irrigation systems	Planting patterns											
	Gross sugar (%)				White sugar (%)				Loss sugar (%)			
	Ridges	Platforms	Rows	Mean	Ridges	Platforms	Rows	Mean	Ridges	Platforms	Rows	Mean
	2005/06 season											
Improved mesqa	17.37	17.38	17.51	17.42 a	13.94	13.55	13.71	13.73 a	3.89	3.72	3.51	3.70
Traditional mesqa	17.02	17.40	17.12	17.18 b	13.07	13.67	13.21	13.32 b	3.70	3.38	3.45	3.51
Mean	17.19 b	17.39 a	17.31 ab	-	13.51	13.60	13.46	-	3.80	3.55	3.48	
Interaction LSD 5%	0.12				NS				NS			
	2006/07 season											
Improved mesqa	17.18	17.22	17.00	17.13 a	13.22	13.59	13.45	13.55 a	3.64	3.43	3.56	3.54 b
Traditional mesqa	17.03	16.95	16.95	16.97 b	13.14	12.72	13.02	12.96 b	3.57	3.94	3.81	3.77 a
Mean	17.10	17.08	16.97	-	13.18	13.16	13.24	-	3.60	3.68	3.68	
Interaction LSD 5%	0.20				NS				NS			

Means designated by the same letter within the same rows or column for each season are not significantly different at 5% level, according to Duncan's multiple range test and L.S.D. test for interactions.

In general, sowing beets on platforms produced the highest gross sugar % compared with that obtained by ridges and rows pattern. At the same time the improved mesqa irrigation with platform patterns gave the highest gross sugar % (17.51 and 17.22%) in both seasons, respectively Table 7. Similar results were found by Kamel *et al.* (1981), El-Khatib (1991), Hilal (2000), Shams El-Din (2000) and Meleha (2002).

2. White sugar percentage:

An inherent inverse relationship exists between sugar beet root yield and sucrose concentration. Increasing root yields by improved agronomic practices will generally decrease sucrose concentration.

Doney *et al.* (1981) and Doney (1984) have both reported an inverse relationship between root cell size and sucrose concentration, and have suggested that the negative correlation results from the opposite effects of cell size on root yield and sucrose concentration. Large cells produce large roots with high root yields and low sucrose concentration; whereas small cells produce small roots with low root yields and high sucrose concentration.

Increasing the Na concentration or decreasing the K: Na ratio by increased N uptake, increase the root water concentration with a reduction in sucrose concentration. These variations in water content indicate that root Na content and/or K: Na ratios may be involved in the inverse relationship between root yield and sucrose concentration (Carter, 1986).

The mean values of extractable white sugar percentage at harvest as affect by irrigation systems, planting patterns and their interactions are presented in Table 7.

White sugar percentage showed a slight positive response to the irrigation systems in both seasons. Data in Table 7 revealed that maximum white sugar % for both seasons (13.73 and 13.55%0 obtained from improved mesqa irrigation meanwhile, the lowest one (13.32 and 12.96%) was obtained from traditional mesqa irrigation. on the other hand, white sugar percentage in root juice was not significantly affected by planting patterns and the interaction effect between irrigation systems and planting patterns.

3. Loss sugar percentage:

The effect of irrigation systems, planting patterns and their interactions on the sugar losses percentage in both seasons were presented in Table 7. The irrigation systems had no significant effect on the percentage of sugar losses at the first season but it had significant effect at the second one. At the same time the planting patterns and the interaction had insignificant effect on these traits (Table 7).

4. Juice purity percentage:

Data in Table (8) showed the effect of irrigation systems and planting patterns on juice purity % at both seasons. There was no evidence for significant difference in Juice purity percentage due to irrigation system and planting methods.

Table (8) Effect of irrigation systems, planting patterns and their interactions in juice purity percentage at harvest in 2005/06 and 2006/07 seasons.

Irrigation system	Planting patterns			Mean
	Ridges	Platforms	Rows	
	2005/06 season			
Improved mesqa	76.37	76.61	77.99	76.99
Traditional mesqa	76.01	79.27	78.02	77.77
Mean	76.18	77.94	78.01	-
Interaction LSD (5%)	NS	-	-	-
	2006/07 season			
Improved mesqa	76.89	77.64	76.76	77.09
Traditional mesqa	76.52	75.09	77.04	76.22
Mean	76.70	76.37	76.91	-
Interaction LSD (5%)	NS	-	-	-

Means designated by the same letter within the same row or column for each season are not significantly different at 5% level, according to Duncan's multiple range test and L.S.D. test for interactions.

5. Soluble non-sugars:

The three main impurities in sugar beet roots which decrease the amount of white sugar extractable in the factory are potassium, sodium and α-amino nitrogen. These ions are difficult to precipitate and pass through the process to the crystallization stage. As their concentration increases so the amount of molasses produced also increases with commensurate decrease in white sugar crystallized (Last *et al.*, 1983).

Table (9) shows the effect of irrigation systems and planting distribution on the concentration of impurities at final harvest. Different irrigation systems and sowing methods had no significant effect on the soluble non-sugars, K, Na and α-amino-N in fresh root at the two seasons.

Table (9): Effect of irrigation systems, planting patterns and their interactions on K, Na and ∝-amino-N contents in fresh root (meq/100 g beet) at harvest in 2005/06 and 2006/07 seasons.

Irrigation systems	Planting patterns											
	K meq/100 g				Na meq/100 g				∝-amino-N meq/100 g			
	Ridges	Platforms	Rows	Mean	Ridges	Platforms	Rows	Mean	Ridges	Platforms	Rows	Mean
	2005/06 season											
Improved mesqa	7.58	7.19	6.99	7.26	1.77	1.72	1.72	1.73	4.70	4.34	4.14	4.39
Traditional mesqa	7.49	6.63	6.87	7.00	1.82	1.77	1.72	1.77	4.14	3.88	4.07	4.03
Mean	7.54	6.90	6.93	-	1.79	1.74	1.72	-	4.42	4.11	4.10	-
Interaction LSD 5%	NS	-	-	-	NS	-	-	-	NS	-	-	-
	2006/07 season											
Improved mesqa	7.27	7.14	7.08	7.16	1.78	1.69	1.67	1.71	4.43	3.85	4.17	4.14
Traditional mesqa	7.28	7.71	7.19	7.40	1.80	1.90	1.69	1.80	4.51	4.41	4.44	4.45
Mean	7.28	7.43	7.13	1.79	1.79	1.68	1.68	-	4.47	4.12	4.30	-
Interaction LSD 5%	NS	-	-	-	NS	-	-	-	NS	-	-	-

Means designated by the same letter within the same rows or column for each season are not significantly different at 5% level, according to Duncan's multiple range test and L.S.D. test for interactions.

CONCLUSIONS

Field water applied by irrigation and planting distribution are important factors for root yields and technological quality of sugar beet. Cultivation of sugar beet under improved irrigation system is better than that of traditional one in root yield, quality and water saving (water saving ratio was 17.36%). Platform pattern is recommendable as a agricultural technique because of high root yield, good quality of sugar and water saving (water saving ratio was 19.56% comparing with other planting patterns). We intend to train the farmers at North Delta region to introduce these new agricultural techniques of irrigation.

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تأثير نظم اضافة ماء الرى وتوزيع النباتات على محصول الجذور والصفات التكنولوجيه لبنجر السكر فى منطقة شمال الدلتا

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الملخص العربى

أجريت تجربتان حقليتان فى حقول المزارعين بمنطقة شمال الدلتا خلال موسمى ٢٠٠٥/٢٠٠٦ ، ٢٠٠٦/٢٠٠٧م وذلك لدراسة تأثير نظم اضافة ماء الرى عن طريق (الرى المتطور والرى التقليدى) وكذلك نظم توزيع النباتات (الزراعة على خطوط ، مصاطب ، صفوف) على محصول الجذور والصفات التكنولوجية لبنجر السكر.

استخدم تصميم القطع المنشقة مرة واحدة فى اربع مكررات حيث تم توزيع معاملات نظم الرى فى القطع الرئيسية ومعاملات توزيع النباتات فى القطع المنشقة.

وقد أوضحت النتائج المتحصل عليها الاتى:

- تحت نظام الرى المتطور ارتفع محصول كل من الجذور ومحصول السكر الكلى ـ نسبة ومحصول السكر الابيض وذلك بالمقارنة بنظام الرى التقليدى فى نفس الوقت حقق نظام الرى المتطور أعلى قيمة لكفاءة استخدام ماء الرى (FWUE) مقارنة بالرى التقليدى. خلال موسمى الدراسة.
- أدى زراعة النباتات على مصاطب الحصول على أعلى القيم من محصول الجذور ومحصول السكر الكلى والابيض وكذلك أعلى قيمة لكفاءة استخدام ماء الرى مقارنة بالزراعة على خطوط او صفوف.
- أوضحت النتائج أن استخدام نظام الرى المتطور أدى الى توفير ماء الرى بنسبة (١٧,٢٩ ، ١٧,٤٤%) فى حين أدى زراعة النباتات على مصاطب الى توفير ماء الرى بنسبة (٢٠ ، ١٩,١٢%) فى كل من الموسم الاول والثانى على التوالى.