YIELD AND QUALITY OF SUGAR BEET CROP AS AFFECTED BY IRRIGATION INTERVAL, CULTIVARS AND POTASSIUM FERTILIZATION IN NORTH DELTA

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ABSBTRACT

Field experiments were carried out during 2007/2008 and 2008/2009 growing seasons at Sakha Agricultural Research Station, Kafr El-Sheikh governorate to study the yield and quality characteristics of sugar beet plant as affected by different irrigation intervals, two cultivars and K-fertilization under North Delta condition. The split-split plot design with three replicates was used. The irrigation intervals (as main plots) were every 3, 5 and 7 weeks. The two cultivars were Dlsperez and LP-13 (as subplots), whereas the three potassium fertilizer rates (0, 24 and 48 kg K_2O/fed) were arranged in the sub-sub plots.

The obtained results under the condition of the studied area show that increasing the drought period (irrigation every 7 weeks) resulted in a significant increase in root length, root/top ratio, gross sugar % and white sugar % and decrease in root and top yield (t/fed) and root diameter, while the soluble non-sugar content, gross and white sugar yields (t/fad), loss sugar yield as well as juice purity were not affected by the different irrigation intervals.

There was no evidence for significant different in most studied traits due to the two sugars cultivars.

With respect to potassium fertilizer, increasing its level from 0 to 48 kg K_2O/fad. led to significant increases in all studied traits except in case of Na and α-amino-N content in beet.

INTRODUCTION

Increasing water use efficiency in irrigated agriculture and promoting dry land farming will both play a significant role in maintaining food security. Egypt is a country of water scarcity due to general low precipitation, high evaporation and the temporal and spatial distribution of rainfall. Irrigation water therefore plays an essential role in agricultural practices and particularly in all crops cultivation. Sugar beet can be grown in a wide range of climatic conditions and is noted for its tolerance to salinity but drought stress is one of the major factors causing profit loss of the sugar beet crop. However, sugar beet could be efficiently grown under a wide range of irrigation level, where it is readily adapted to limited irrigation because plants utilize deep stored soil water and recover quickly following water stress (Monreal *et al*., 2006).

Sugar beet is classified as a plant that need high potassium requirements, where more of it is absorbed by sugar beet than any other nutrient element. Potassium fertilization also become important for sugar beet particularly in Northern Delta soils. Potassium is greatly required by sugar beet. It is very mobile in plant tissues and was found throughout the plant. It is important to photosynthesis, and sugar produced relies on potassium for movement to the storage tissues in the root. At harvest, plants given potassium has significantly greater sugar percentage than those given none. Potassium also improves performance by increasing leaf area in growth stages (Cooke and Scott, 1993). Potassium uptake depends upon N uptake, plant growth, availability of K, year and genotype (Carter, 1986). Many investigators reported that root length, root fresh weight, sucrose percentage, top, root and sugar yields (t/fed) were increased significantly with increasing potassium fertilizer rates (Beringer *et al*., 1986; Hegazy *et al*., 1992; Edris *et al*., 1992, 2002 and Hilal, 2005).

A few variation among sugar beet cultivars in yield and quality were reported by many investigations (Leilah and Nasr, 1992 and Shehata *et al*., 1994).

The aim of this study was to see the effects of three irrigation intervals (every 3 weeks, 5 weeks and 7 weeks and three potassium fertilizer rates (0, 24 and 48 kg K_2O/fad) on yield and quality of two sugar beet cultivars (Dlsperez and LP-13).

MATERIALS AND METHODS

Two series of field experiments were conducted at Sakha Agricultural Research Station, Agricultural Research Center in the two successive growing seasons 2007/2008 and 2008/2009 to study the effect of irrigation intervals, cultivars and potassium fertilizer on yield and quality of sugar beet.

Soil samples were randomly taken from the experimental sites at a depth of 30 cm from soil surface and were prepared for both physical and chemical properties (mean of two seasons).

Its mechanical analysis (sand 23.86%, silt 22.54% and clay 53.61%). The soil type was clay texture. While its chemical analysis was [pH 8.30, organic matter 1.99%, soil salts (EC dS/m 2.82), available N (ppm) 22.62. Available P (ppm) 7.05 and available K (ppm 278.16)].

The preceding summer crop was corn in both seasons. Sugar beet was sown on 1/10/2007 and 5/10/2008 seasons. Soils were fertilized with 30 kg P_2O_5/fad in the form of calcium super phosphate (15.5% P_2O_5) during soil preparation 90 kg N/fad in form of urea (46.5% N) were applied in two equal doses, after thinning and 25 days later.

Seed of multigerm sugar beet cultivar (DIsperez and LP-13) were planted by hand in hills approximately 3-4 seed balls per hill. Plants were thinned to one plant per hill after 35 days from sowing. Other cultural practices were done as recommended, in sugar beet fields.

A split-split plots design with three replications was used in both seasons. The experiment included 18 treatments, which were the combination between three irrigation intervals (every 3 weeks, 5 weeks and 7 weeks), which were distributed in the main plots, two sugar beet cultivars (DIsperez and LP-13) were allocated randomly in sub-plots and three potassium rates (0, 24 and 48 kg K_2O/fed) which were occupied the sub-sub plots. Potassium fertilizer was applied in two equal doses, the 1st one was applied before sowing and the 2nd dose after 20 days. Plot area was (25.2 m^2), included six ridges, 7 m length, with 60 cm apart and 20 cm between hills. The outer two ridges were considered as belt or band. The central ridges were kept to determine yield and its attributes and quality.

The collected data in both seasons involved the following traits:

At maturity (210 days from sowing) a central area of 16.8 m^2 from each plot were harvested at both seasons, to estimate the following: yield and its attributes:

1. Root length (cm)
2. Root diameter (cm)
3. Root yield (t/fad)
4. Top yield (t/fad)
5. Root/top ratio
6. Gross sugar yield (t/fad) = root yield (t/fad) x gross sugar percentage.
7. White sugar yield (t/fad) = root yield (t/fad) x white sugar percentage.
8. Losses sugar yield (t/fad) = root yield (t/fad) x loss sugar percentage.

Quality parameters:

All parameters were determined in Delta Sugar Company Limited Laboratories at El-Hamoul, Kafr El-Sheikh Governorate according to the method of McGinnus (1971).

The parameters of quality included:

1. **Gross sugar %**

Juice sugar content of each treatment was determined by means of an Automatic Sugar Polarimetric according to McGinnus (1971).

2. **Extractable white sugar%:**

Corrected sugar content (white sugar) of beets was calculated by linking the beet non-sugar K, Na and α-amino (expressed as a milliequivalent/100 g of beet) according to Harvey and Dutton (1993) as follows:

$$ZB = pol-[0.343(K+NA) + 0.094\ AmN + 0.29]$$

Where:

ZB = Corrected sugar content (% per beet) or extractable white sugar

Pol = Gross sugar %

AmN = α-amino-N determined by the "blue number method".

3. **Loss sugar% = Gross sugar % - white sugar %**

4. **Juice purity percentage**

$$\text{Juice purity \% (Qz)} = \frac{ZB}{Pol} x100$$

5. **Soluble non-sugar 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 collected data were subjected to statistical analysis of variance as described by Gomez and Gomez (1984). The mean values were compared according to Duncan's Multiple Range Test (Duncan, 1955). All statistical analyses were performed using analysis of variance technique means of "MSTATC" computer software package.

RESULTS AND DISCUSSION

The results obtained from the present investigation in the two seasons of 2007/08 and 2008/09 are presented and discussed in two topics:

I. **Yield and its components:**

1. **Root length (cm)**

Root length was significantly increased with lengthest irrigation period (Table 1). Irrigation interval every 7 weeks gave a significant increase in root length (43.60 and 42.50 cm) in both seasons, respectively. In the present study indicated that, proportionately; higher root length might be possible by the application of relatively low amounts of irrigation water. Similar observations were reported by Besheit *et al*. (1996) and El-Maghraby *et al*. (2008).

Table (1): Root dimensions (cm), root yield (t/fed), top yield and root/top ratio as affected by irrigation intervals, cultivar and potassium fertilizer in 2007/08 and 2008/09 seasons.

Factors	Root length		Root diameter		Root yield		Top yield		Root/top ratio	
	2007/08	2008/09	2007/08	2008/09	2007/08	2008/09	2007/08	2008/09	2007/08	2008/09
Irrigation intervals (I)	**	**	**	NS	**	*	**	**	**	**
Every 3 weeks	36.63 c	35.33 c	16.07 a	14.50	27.92 a	25.89 a	12.05 a	10.87 a	2.33 c	2.39 c
Every 5 weeks	41.28 b	42.16 b	15.75 b	14.33	26.49 b	24.89 b	10.62 b	9.94 b	2.50 b	2.52 b
Every 7 weeks	43.60 a	42.50 a	14.61 c	14.27	24.40 c	24.25 c	8.48 c	8.77 c	2.88 a	2.77 a
Cultivar (C)	**	NS	**	NS	NS	NS	NS	NS	NS	NS
Disperez	39.74 b	40.03	15.75 a	14.41	26.46	25.13	10.29	9.85	2.59	2.57
Lp-13	41.27 a	39.96	15.20 b	14.33	26.08	24.89	10.48	9.87	2.55	2.55
Potassium rates (kg K_2O/fed)	**	NS	**	NS	**	**	**	**	**	NS
0	37.13 b	38.70	14.58 c	14.66	24.54 c	23.28 c	9.28 c	9.10 c	2.66 a	2.57
24	42.09 a	40.40	15.65 b	14.16	26.44 b	25.31 b	10.56 b	9.87 b	2.55 b	2.58
48	42.28 a	40.70	16.20 a	14.27	27.83 a	26.33 a	11.31 a	10.61 a	2.50 c	2.52
Interaction										
I x C	**	NS	**	NS	**	**	**	**	**	**
I x K	**	NS	**	NS	**	NS	**	NS	*	NS
C x K	**	NS	**	NS	**	NS	**	NS	**	NS
I x C x K	**	NS	**	NS	NS	NS	NS	NS	**	NS

*, ** and NS indicate P<0.05, P0.01 and not significant, respectively. Means followed by the same letter are not significantly different at 5% level of significancy.

Significant differences were found between the two cultivars under consideration in the first season. No differences were recorded between them in the second season (Table 1).

Potassium rates had a significant effect on root length only in in first season. Application of 24 or 48 kg K_2O/fad resulted in the highest (42.09, 42.28 and 40.40, 40.70) in the first and second seasons, respectively (Table 1). The increases in root length may be due to increasing in photosynthesis and translocation as assimilates to storage root for K on plant (Samwel *et al*., 1990 and Cooke and Scott, 1993). On the other hand, Sarhan (1998) reported that potassium fertilizer had insignificant effect on root length.

The interaction effect between (I x C, I x K, C x K and I x C x K) had a highly significant effect on root length only in the first season.

2. Root diameter (cm):

The effect of irrigation intervals, cultivars and potassium fertilizer on root diameter during the two seasons are presented in Table (1).

Irrigation had highly significant effect on root diameter in the first season only. But the results in Table (1) revealed that root diameter was not significantly affected by irrigation intervals in the second season. However, the thinnest diameter was obtained from irrigation every 7 weeks.

In the first season, the analysis of variance show that the roots of var. Dlsperez was thick than LP-13. But, such differences did not reach the level of significance in the second one (Table 1).

Root diameter exhibited significant differences among potassium rates. Increasing potassium levels from 0 up to 48 kg K_2O/fad. significantly increased root diameter in the first season, but insignificant difference in the second one was found (Table 1).

The interactions among irrigation intervals cultivars and potassium fertilizer were significant in the first season and were insignificant in the second one.

3. Root yield (t/fad)

Root yield as affected by irrigation intervals, cultivars, K-fertilizer and their interaction are shown in Table (1).

Statistical analysis show that the root yield was significantly affected by irrigation intervals in both seasons. Irrigation every 3 weeks gave the highest root yield (27.92 and 25.89 t/fad) followed by every 5 weeks (26.49 and 24.89 t/fad) and the lowest root yield was obtained by irrigation every 7 weeks (24.40 and 24.25 t/fad) in the two seasons, respectively. Draycott and Messem (1977) reported that the main factors controlling the yield response to irrigation were period and size of deficit. Sepaskhah and Kamger-Haghighi (1997) found that the furrow irrigation at 10 days and 6 days intervals produced a similar root yield. On the other hand, Tognetti *et al.* (2003) found that plots irrigated with surface drip irrigation produced the highest sugar beet yield, but furrow irrigation produced the lowest one. However, higher root yield with irrigation every 3 weeks compared to every 5 or 7 weeks in this experiment is in agreement with the results reported by Besheit *et al.* (1996), and Hassanli *et al.* (2010). On the other hand, Isoda (2007) found that the irrigation led to an increase in the net sugar yield due to an increase in the root yield. However, there was a slight reduction in the sugar content in roots. Ancuta *et al.* (2007) noticed that in cultivated sugar beet under rainfall conditions, which excluded the use of irrigation, all factor graduals of irrigation regime had practically equal yields.

Root yield (t/fad) was slightly affected by the two cultivars studied in both seasons (Table 1). However, the two varieties recorded insignificant differences between them for this trait.

Potassium fertilization had a highly significant effect on sugar beet root yield in both seasons. Data presented in Table (1) show that the highest root yield was produced with 48 kg K_2O/fad., (27.83 and 26.33 t/fad.) compared with the control (24.54 and 23.28 t/fad) in two seasons, respectively. Such increase in root yield may be attributed to the increase of dry matter, transportation, accumulation and to some extent to an increase of root length and diameter. Also, the role of K could be explained through its need as cofactor (enzymes activator) for different enzymes. In addition, K is needed for vital processes and its beneficial effect in translocation of carbohydrates to the storage organs. Saxena (1985) show that K may favorably influence water relations of plants and maintain yield under water stress. Also, the osmotic potential of the storage root was decreased with increasing K nutrition. Betaine, at final harvest, was significantly increased with increasing K concentration in the storage root (Beringer *et al.* 1986). The obtained results agree with those of Yu-Ying and Hong (1997), Zengin *et al.* (2009) and Hassanli *et al.* (2010).

The interaction between the three factors had a significant effect on root yield (t/fed) in the first season except that between (I x C x K). The data show that, the highest value of root yield obtained from irrigation every 3 weeks and both cultivars (27.81 and 28.03 t/fad). While the lowest one obtained from irrigation every 7 weeks and both cultivars (24.97 and 23.83 t/fad) (Table 2). At the same time the highest values of root yield were obtained from irrigation every 3 weeks and 45 kg K_2O (30.20 t/fad). Generally the 45 kg K_2O/fed. with all irrigation intervals obtained the highest root yield compared with other interaction (Table 3). Data show that the highest root yield obtained from 48 kg K_2O/fed and both cultivars (28.08 and 27.58 t/fad) (Table 4).

The interaction among all treatments had insignificant effect on root yield in the second season, except that between irrigation intervals and cultivars.

Table (2): Mean values of roots and top yield (t/fad) of sugar beet as affected by irrigation intervals and cultivars interaction in 2007/08 season.

Treatment	Root yield (t/fad)		Top yield (t/fad)	
	Cultivars			
Irrigation intervals	Disperez	LP-13	Disperez	LP-13
Every 3 weeks	27.81 a	28.03 a	11.56 b	12.53 a
Every 5 weeks	26.61 b	26.38 b	10.45 d	10.80 c
Every 7 weeks	24.97 c	23.83 d	8.85 e	8.12 f
Sig.	**		**	

Table (3): Mean values of roots and top yield (t/fad) of sugar beet as affected by irrigation intervals and K-fertilizer interaction in 2007/08 season.

Treatment	Root yield (t/fad)			Top yield (t/fad)		
	Potassium rates (K_2O kg/fed)					
Irrigation intervals	0	24	48	0	24	48
Every 3 weeks	25.13 d	28.43 b	30.20 a	10.30 c	12.51 b	13.33 a
Every 5 weeks	24.88 d	26.35 c	28.25 b	9.41 f	10.75 d	11.71 c
Every 7 weeks	23.61 c	24.53 d	25.06 c	8.15 9	8.43 i	8.88 h
Sig.	**			**		

Table (4): Mean values of roots and top yield (t/fad) of sugar beet as affected by cultivars and K-fertilizer interaction in 2007/08 season.

Treatment	Root yield (t/fad)			Top yield (t/fad)		
	Potassium rates (K_2O kg/fed)					
Cultivars	0	24	48	0	24	48
Disperez	24.30 d	27.01 b	28.08 a	9.34 d	10.26 c	11.26 a
LP-13	24.78 d	25.87 c	27.58 a	9.23 d	10.86 b	11.35 a
Sig.	**			**		

4. Top yield (t/fad)

The mean values of top yield (t/fad) at harvest as affected by irrigation intervals, cultivars, K-fertilizer and their interaction are presented in Tables (1-4).

In general, the trend of the effect of irrigation intervals, cultivars, K-fertilizer and their interaction on top yield was similar to that of root yield and similar discussions could be cited (Table 1-4).

5. Root/top ratio:

Concerning the effect of irrigation intervals on root/top ratio, it is obvious from data collected in Table (1) that irrigation intervals had a significant effect on root/top ratio in both seasons. Meanwhile, irrigation every 7 weeks recorded the highest values of root/top ratio (2.88 and 2.77), compared with irrigation every 3 weeks (2.33 and 2.39) in both seasons, respectively. These results are in accordance with those reported by El-Maghraby *et al*., (2008).

Results show that insignificant difference existed between the two varieties in both seasons.

Regarding the effect of K-fertilizer, data show significant differences among them in the first season only (Table 1). The highest average values root/top ratio were obtained from the control followed by (24 and 48 K_2O/fad). On the other hand, El-Kammah (1995) found that root/top ratio was significantly increased by K-fertilizer.

In general, the trend of the effect of interaction on root/top ratio was similar to that of (root and top yield) and similar discussions could be cited Table (1).

6. Gross sugar yield (t/fad)

With regard to the effect of irrigation intervals data in Table (5) show that gross sugar yield was not significantly affected by all irrigation intervals in both seasons. Similar results were reported by Sepaskhah and Kamgar-Haghighi (1997) and Isoda (2007) (every 6 weeks). However, Ibrahim *et al.* (2002) show that sugar yields were increased significantly with increasing the period of drought. Hassanli *et al.* (2010) found that both the sugar beet yield (root yield) and sugar yield (pure sugar) were significantly affected by the irrigation interval.

The analysis of variance show that significant differences existed between the two varieties in the first season only, where LP-13 var. outyielded DIsperez var. The mean values were (4.84 and 4.70 t/fad) in the first season (Table 5).

Table (5): Gross, white and loss sugar yield (t/fad) and gross, white and loss sugar percentage as affected by irrigation intervals, cultivar and potassium fertilizer in 2007/08 and 2008/09 seasons.

Factors	Gross sugar yield		White sugar yield		Loss sugar yield		Gross sugar		White sugar		Loss sugar	
	t/fad						%					
	2007/08	2008/09	2007/08	2008/09	2007/08	2008/09	2007/08	2008/09	2007/08	2008/09	2007/08	2008/09
Irrigation intervals (I)	NS	NS	NS	NS	NS	NS	**	*	**	*	NS	NS
Every 3 weeks	4.84	4.25	3.87	3.43	1.23	0.82	17.33 c	16.45 c	13.73 c	13.26 c	3.60	3.18
Every 5 weeks	4.76	4.17	3.89	3.46	1.45	0.70	17.99 b	16.77 b	14.69 b	13.92 b	3.32	2.84
Every 7 weeks	4.72	4.22	3.83	3.41	1.13	0.80	18.98 a	17.39 a	15.71 a	14.06 a	3.59	3.33
Cultivar (C)	*	NS	*	NS	NS	NS	**	NS	**	NS	NS	NS
DIsperez	4.70 b	4.26	3.76 b	3.47	1.17	0.79	17.63 b	16.97	14.26 b	13.81	3.54	3.16
Lp-13	4.84 a	4.17	3.96 a	3.40	1.36	0.76	18.56 a	16.76	15.16 a	13.68	3.46	3.08
Potassium rates (kg K_2O/fed)	**	**	**	*	*	*	**	NS	**	NS	**	NS
0	4.30 c	3.90 c	3.55 c	3.17 c	1.12 c	0.73 c	17.71 c	16.78	14.35 c	13.65	3.18 c	3.12
24	4.81 b	4.29 b	3.87 b	3.49 b	1.26 b	0.79 b	18.02 b	16.96	14.71 b	13.80	3.55 b	3.15
48	5.21 a	4.46 a	4.16 a	3.64 a	1.43 a	0.81 a	18.57 a	16.87	15.06 a	13.79	3.78 a	3.08
Interaction												
I x C	NS	NS	NS	NS	NS	NS	**	NS	**	NS	*	NS
I x K	**	NS	NS	NS	**	NS	NS	NS	**	NS	NS	NS
C x K	**	NS	**	NS	NS	NS	*	NS	**	NS	NS	NS
I x C x K	NS	NS	NS	NS	NS	NS	*	NS	NS	NS	NS	NS

*, ** and NS indicate P<0.05, P0.01 and not significant, respectively. Means followed by the same letter are not significantly different at 5% level of significancy.

Potassium fertilization had a highly significant effect on gross sugar yields (t/fad). The highest average of sugar yield (5.21 and 4.46 t/fad.) were obtained with addition of 48 kg K_2O/fad as compared with the control treatment (4.30 and 3.90 t/fad) in the first and second seasons, respectively (Table 5).

However, Herlihy (1989) reported that the agronomic effect of K was to increase yield rather than quality, consistent with its dominant rate in increasing the sink capacity and mass of the storage root. Loue (1985) reported that application of 200 kg K_2O/ha increased richness in sugar and K content, whilst it reduced the harmful contents of alpha-amino-N and Na in sugar beet roots.

Furthermore, several investigators found that K increased root weight by improving transport of metabolites to the storage organs. Also, high K rates affected root beet quality by influencing sugar content, extractability of high sugar concentration and yield of refined sugar (Beringer *et al.*, 1986 and Ibrahim *et al.*, 2002).

The interaction between (drought periods x K-fertilization and cultivar x K) on gross sugar yield was highly significant during the first season (Table 5).

7. White sugar and loss sugar yield (t/fad)

White sugar yield is an important yield parameter for sugar beet because it is useful form of sugar that the consumer use. Also, the most sugar losses in sugar factories resulted from the sugar in molasses, which is not crystallized. It is estimated by the major non-sugar components in the beet. Although the efficiency of sugar recovery depends to a large extent on the factory equipment, the beet quality is by fact the most important parameters affecting the process (Bosemark, 1993).

In general, the trend of the effect of irrigation intervals, cultivars, K-fertilizer and their interaction on white sugar yield and loss sugar yield were similar to that of gross sugar yield and similar discussions could be cited (Table 5).

II. Quality parameters:

1. Gross and white sugar percentages:

Invert sugar is a mixture of glucose and fructoses that results from the hydrolysis of sucrose. The invert sugar content of the beet increases with the duration of storage and significantly under the influence of pathogenic processes. It can be considered as a criterion of sucrose loss. Invert sugar is marketed as a component of invert sugar syrup. Functional use in foods is as nutritive sweetener (Europabio, 2003).

Values of gross and white sugar percentages as affected by irrigation interval, cultivar and potassium fertilization were shown in Table (5). Data show that gross and white sugar percentages were significantly increased with increasing the irrigation intervals. The highest values of gross sugar percentage (18.98 and 17.39%) and white percentage (15.71 and 14.06%) were obtained under the lengthest period of drought treatment (irrigation every 7 weeks) in both seasons, respectively. While, the lowest one were found under (every 3 weeks). These obtained results were in good agreement with those of Ibrahim *et al.* (2002), Isoda (2007) and Hassanli *et al.* (2010).

In general, LP-13 var. outyielded significantly Dlsperez var. in the first season, but in the second one such differences didn't reach the level of significant, in respect to gross and white sugar percentage (Table 5).

Increasing the rate of potassium fertilization significantly increased the gross and white sugar percentage only in the first season (Table 5). The highest values due to K-fertilization were found to be (18.57%) for gross sugar percentage and (15.06%) for white sugar percentage with the application of 48 kg K_2O/fad in the first season.

Carter (1986) pointed out that sucrose recovery efficiency from the sugar beet depends on the amounts and types of root and extracted juice impurities. The proportion and amount of K in the beet plant may be also important because of a positive correlation between K-fertilization and sucrose concentration (wet root%) in root. El-Sheref (2006) found that the gross sugar percentage in root juice was not significantly affected by increasing potassium rates from 24 to 48 kg K_2O/fad. On the other hand, the data collected by Zenging *et al.* (2009) indicated that gross and white sugar content was increased significantly by increasing K-fertilizer rates.

The interaction among all treatments had insignificant effects on gross and white sugar % in the second season, but in the first one the interaction between (irrigation x cultivar, cultivar x potassium and irrigation x cultivars x potassium fertilizer) for gross sugar %, and the interaction among all treatments except (I x C x K) for white sugar%. Such differences reach the level of significance.

2. Loss sugar percentage:

The effect of different irrigation intervals, cultivar and K-fertilizer rates on the sugar losses % in both seasons were presented in Table 5. All treatments of irrigation intervals and cultivar had no significant effect on sugar losses % in both seasons.

In general, data show that the sugar loss % was significantly increased by increasing of K-fertilizer rate up to 48 K_2O/fad. only in the first season (Table 5). Similar results were also recorded by El-Sheref (2006).

The interaction between the three factors under study had insignificant on loss sugar % in both seasons, except that between irrigation intervals x cultivars in the first season, effect in both seasons which indicate independent effect for each factor on this criterion.

3. Juice purity percentage:

In general, the trend of the effect of irrigation interval, cultivars and K-fertilizer rates on juice purity % was similar to that of loss sugar % and similar discussions could be cited (Table 6). The obtained results were in good agreement with those of El-Sheref (2006). In contrast, Ibrahim *et al.* (2002) and Hilal (2005) found that purity percentage was significantly increased by increasing K fertilizer rates and water stress several weeks before harvest. Also, Bosemark (1993) reported that the chemical characteristics of sugar beet juice was mainly affected by the sugar crystallization process. There are high sucrose content associated with low contents of K, Na and alpha-amino-N and betaine contents. It is also important for stability of juice in the factory that the content of alpha-amino-N would be maintained low in relation to that of K and Na ions.

The interaction among all treatments had insignificant effects on juice purity % in both seasons.

4. Soluble non-sugar content:

The non-sucrose substances in sugar beet roots include other soluble saccharides, cell wall components, proteins free amino acids, betaine as well as organic and inorganic ions and other nitrogen free acids. Inorganic anions include phosphates, chlorides, sulfates and nitrate of ubiquitous cations mainly potassium, sodium, calcium magnesium and ammonium. The non-sucrose components most relevant for "technical quality" of sugar beet are potassium, sodium and alpha-amino nitrogen (Europabio, 2003).

The soluble non-sugars K, Na and alpha amino-N in fresh root (mg/100 g beet) are regarded as impurities because they interfere with sugar extraction. Values of K, Na and α-amino-N as affected by irrigation interval, cultivars and potassium fertilization were shown in Table (6). There was no evidence for significant difference in soluble non-sugar due to irrigation interval in the first season for K% and α-amino-N % and in the two seasons for Na%. At the same time the irrigation intervals every 7 weeks gave the highest values of K% and α-amino-N% (6.01 and 3.07) in the second season, respectively. Concerning the effect of cultivars, data show that insignificant differences existed among them. With regard to the effect of potassium levels on soluble non-sugar content, data show that increasing the rate of K-application resulted in increases in K content (5.69 and 5.88) in both seasons and Na content (3.72) in the second season. On the other hand, α-amino-N content in root was not significantly affected by potassium application in both seasons (Table 6). These obtained results were in good agreement with those of Loue (1985). The interaction between irrigation intervals and K-fertilizer had a significant effect on the soluble non-sugar content.

Table (6): Juice purity percentage, K, Na and α-amino-N content (in meq./100 g of beet) as affected by irrigation intervals, cultivar and potassium fertilizer in 2007/08 and 2008/09 seasons.

Factors	Juice purity, %		K		Na		α-amino N	
			meq/100 g of beet					
	2007/08	2008/09	2007/08	2008/09	2007/08	2008/09	2007/08	2008/09
Irrigation intervals (I)	NS	NS	NS	*	NS	NS	NS	*
Every 3 weeks	90.61	89.22	5.30	5.80 b	2.13	3.54	2.77	2.25 b
Every 5 weeks	90.93	90.61	5.56	5.32 c	2.08	3.06	2.79	1.88 c
Every 7 weeks	91.17	88.84	5.43	6.01 a	2.12	3.72	2.68	3.07 a
Cultivar (C)	NS	NS	NS	NS	NS	NS	NS	NS
DIsperez	90.87	89.58	5.41	5.72	2.13	3.48	2.68	2.38
Lp-13	90.94	89.54	5.45	5.69	2.09	3.41	2.73	2.42
Potassium rates (kg K_2O/fed)	**	NS	**	*	NS	*	NS	NS
0	89.79 c	89.93	5.13 c	5.44 b	2.27	3.09 c	3.70	2.47
24	91.21 b	89.27	5.47 b	5.80 ab	2.08	3.72 a	2.81	2.47
48	91.71 a	89.47	5.69 a	5.88 a	2.09	3.52 b	2.60	2.26
Interaction								
I x C	NS	NS	NS	NS	**	*	NS	NS
I x K	NS	NS	NS	**	NS	*	**	*
C x K	NS	NS	NS	**	NS	*	NS	NS
I x C x K	NS	NS	NS	*	NS	**	NS	*

Means followed by the same letter are not significantly different at 5% level of significancy.

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تأثير فترات الرى ــ الأصناف والتسميد البوتاسى
على إنتاجية وجودة محصول بنجر السكر فى شمال الدلتا

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أجريت تجارب حقلية فى محطة البحوث الزراعية بسخا بمحافظة كفرالشيخ فى موسمين زراعيين متتاليين ٢٠٠٧/٢٠٠٨م ، ٢٠٠٨/٢٠٠٩م بغرض دراسة صفات الإنتاج والجودة لمحصول بنجر السكر تحت تأثير فترات الرى ــ صنفين من بنجر السكر والتسميد البوتاسى تحت ظروف منطقة شمال الدلتا.

حيث استخدم تصميم القطع المنشقة مرتين فى ثلاث مكررات وتمثل فيه القطع الرئيسية فترات الرى (الرى كل ٣ ، ٥ ، ٧ أسابيع) والقطع الشقيه تمثل الأصناف (DIsperez, LP-13) فى حين وزعت معدلات التسميد البوتاسى (صفر ، ٢٤ ، ٤٨كجم K_2O/فدان) عشوائيا فى القطع تحت الشقية.

توضح النتائج المتحصل عليها تحت ظروف المنطقة التى أقيمت فيها التجربة الأتى:

- زيادة طول فترة الجفاف (الرى كل ٧ أسابيع) أدت إلى زيادة كل من طول الجذر ونسبة وزن الجذور/للأوراق. ارتفاع نسبة السكر الكلى وكذلك نسبة السكر الأبيض.
- بينما أدت نفس المعاملة إلى نقص محصول الجذور ومحصول الأوراق الطازجة (طن/فدان) وكذلك قطر الجذر.
- ولم يتأثر محتوى الجذور من المواد الغير سكرية ــ محصول السكر الكلى محصول السكر الأبيض (طن/فدان) ــ محصول السكر المفقود وكذلك درجة النقاوة بفترات الرى المختلفة.
- هذا ولم تكن هناك فروق معنوية بين صنفى بنجر السكر تحت الدراسة فى معظم الصفات المدروسة.
- أدت زيادة معدلات التسميد البوتاسى من صفر ــ ٤٨كجم بو٢أ إلى زيادة كل الصفات المدروسة زيادة معنوية فيما عدا محتوى الجذور من الصوديوم والنيتروجين الأمينى (Na and α-amino-N).