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EFFECT OF DROUGHT PERIODS AND POTASSIUM FERTILIZATION RATES ON SOME WATER RELATIONS AND YIELD OF SUGAR BEET CROP AT NORTH NILE DELTA, EGYPT.

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ABSTRACT

The present investigation has been conducted at the experimental farm of El-Karada water management Research Station, (31° 05' N latitude and 30° 56' E longitude), Kafr El-Sheikh Governorate, North Nile Delta, Egypt, during 2008/2009 and 2009/2010 growing seasons, to study the overall impact of drought periods and potassium fertilization rates on some water relations, yield and its components of sugar beet crop at North Delta. A split plot design with four replications has been used; the main plots were assigned to the drought periods before harvesting (three, six and nine weeks). Potassium fertilization treatments (0, 48 and 72 kg KO_2.fed.$^{-1}$) were allocated in the sub–plots. ***The main results in this study can be summarized in the following points.***

1- The highest average value of water productivity (13.68 kg root.m^{-3}), irrigation water productivity (9.28 kg root.m^{-3}) and gross sugar yield (7.26 ton sugar.fed.$^{-1}$) and sources percentage of sugar beet (20.50%) could be achieved with the water stressed treatment (drought period of 9 weeks before harvesting).

2- Potassium fertilization had a highly significant effect on both root and sugar yields, water productivity and irrigation water productivity, source percentage and juice purity during the two growing seasons of sugar beet crop. The deficit of sugar beet yield related to drought for long periods before harvesting, the potassium fertilization can compensate it.

3- The k-fertilization rate of 72 kg.fed.$^{-1}$had been accomplished the highest value of WP(14.12 kg root.m^{-3}), IWP (10.02 kg root.m^{-3}) ,

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root yield (36.85 ton.fed.$^{-1}$), sugar yield (7.41 ton.fed.$^{-1}$), sucrose percentage (21.05 %) and juice purity (83.90%) during the first growing season of 2008 /2009) .

4- Therefore, it could be recommended that application of 72 kg K_2O.fed.$^{-1}$ and withholding the last irrigation at 6 weeks before harvesting at North Delta achieved the highest yield and quality for sugar beet crop, saving about 12% of applied irrigation water.

INTRODUCTION

Sugar beet (*Beta vulgaris* L.) is considered the second main crop for sugar production in Egypt after sugar cane. Recently, sugar beet crop has an important position in Egyptian winter crop pattern, not only in fertile soils, but also in poor, salt affected and calcareous soils.

Irrigation water plays an essential role in agricultural practices, particularly in all crops cultivation. Therefore, increasing water use efficiency in irrigated agriculture, and promoting dry land farming will 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 ***(Abo-Shady et al., 2010).*** However, 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. It could be efficiently grown under a wide range of irrigation levels, 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).*** Irrigation every two or three weeks, especially for the second half of the growing season of the sugar beet resulted in high yield. The values of water consumptive use were 58.06, 55.04 and 49.86 cm fed.$^{-1}$for the 2, 3 and 4 weeks intervals, respectively. The water use efficiency of 8.66 kg for sugar beet root could be obtained from each cubic meter of water consumed ***(Ibrahim et al. 1993).*** The highest sucrose percentage, sugar yield and juice purity were obtained from irrigation by 6cm depth every 2 weeks, ***Eid (1994)***. Increasing the drought period (irrigation every 7 weeks) resulted in significant increase in root length, root/top ratio, gross sugar and white sugar and decrease in root and top yield(ton.fed.$^{-1}$)and loss sugar yield ***(Abo-Shady et al.,2010).***

Sugar beet is classified as a plant that needs high potassium requirements, where more of it is absorbed by sugar beet than any other nutrient element. Potassium fertilization also becomes 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). Abd El-Aziz et al. (1992)*** revealed that application of k fertilizer increased k content of sugar bet than the foliar one. ***Edris et al. (1992)*** found that the highest yield of shoots and roots of sugar beet was obtained with 75 kg N and 96 kg K_2O.fed.$^{-1}$. ***El-Kammah and Ali (1996)*** showed that the sugar beet root yield was affected by potassium fertilization and significantly increased over the control (without dressing) by increasing k application from 0 to 48 kg K_2O.fed.$^{-}$***Ibrahim et al. (2002)*** found that the highest sucrose percentage and juice purity were achieved with K application up to 228.5 kg K_2O. ha^{-1}. The beneficial effect of K fertilization on growth, yield and quality of sugar beet has been widely emphasized in previous studies ***(El-Maghraby et al., 1998; El-Shafai, 2000 and Ouda, 2002).*** Many investigators reported that root length, root fresh weight, sucrose percentage, top, root and sugar yields (ton.fed.$^{-1}$) were increased significantly with increasing potassium fertilizer rates (***Edris et al., 1992*** and ***Hilal, 2005***).

The main objective of the present investigation was, to introduce the most suitable periods of drought before harvesting sugar beet crop, and the best rate of k. fertilization, to optimize water use efficiency and increase the yield production and quality of sugar beet.

MATERIALS AND METHODS

The present investigation was carried out at the experimental farm of El-Karada water management Research Station, (31° 05' N latitude and 30° 56' E longitude), Kafr El- Sheikh governorate, during two growing seasons of 2008/2009 and 2009/2010, to study the overall impact of drought periods and potassium fertilization rates on some water relations, yield and mineral composition of sugar beet at North Delta.

Soils samples were randomly sampled from the experimental sites and prepared for analysis of both physical and mechanical properties. The soil texture was a clay loam. Field capacity, permanent wilting point and bulk density were executed according to Klute (1986). Available soil moisture was calculated by subtracting permanent wilting point from field capacity. Some physical and chemical properties of soil samples for experimental site are presented in Table (1).

Table (1): Some physical and chemical analysis of the tested soil samples for experimental site.

Soil depth	Particle size distribution			Texture class	Bulk density, $Mg.m^{-3}$	Field capacity, %	Per-wilting point, %	Available water %	EC $dS.m^{-1}$	pH	EC of ground water table, $dS.m^{-1}$	EC of irrigation water, $dS.m^{-1}$	Available nutrients $mg.kg^{-1}$		
	Sand, %	Silt, %	Clay, %										N	P	K
0-15	33.0	28.6	38.4	Clay loam	1.12	49.50	26.64	21.86	3.32	7.80	2.3	0.64	22	1.6	18
15-0	33.4	28.4	38.2		1.26	46.02	26.52	19.50	3.58	7.60					
30-45	33.2	28.5	38.3		1.34	44.25	27.86	16.39	3.45	7.70					
45-60	33.0	28.6	38.4		1.38	43.75	27.90	15.33	3.49	7.75					

Experimental layout:

The treatments under study were as follows:

Main: drought periods before harvesting:

A- Three weeks before harvesting (traditional).

B- Sex weeks before harvesting.

C- Nine weeks before harvesting.

Sub: k- fertilization rates:

1- without K fertilization.

2- 48 Kg $K_2O.fed.^{-1}$.

3- 72 Kg K_2O.fed.$^{-1}$.

The experimental plots were arranged in a split plot design with four replicates. The plot area was 52.5 m^2 (7,5 x 7 m)= 1/80 feddan (1 feddan = 0.42 hectar), 1.5 meter apart to prevent side effects.

Seeds of the multigerm Kawemira sugar beet cultivar were planted by hand in hills on November 3rd and 5th in two successive seasons 2008/2009 and 2009/2010 with approximately 3-4 seeds per hill, and harvested after 190 days. The hills were spaced 25 cm apart in rows spaced 60 cm apart. All agricultural practices were done as recommended by the Egyptian Ministry of Agricultural and Land Reclamation, except the two factors of study i.e. drought periods before harvesting and k fertilization rates.

Crop and water parameters:

Furrow irrigation was used. Amount of the delivered water to each plot was estimated using a submerged orifice according to ***Hansen et al., (1980).***

The rate of water application was estimated by checking the time required to fill a container of known volume. The amount of water in each application was added until reaching the end of run length .Water applied (Wa) was calculated as, ***Giriappa (1983):***

$$Wa = Iw + Re + s \qquad (1)$$

Where:

Iw = irrigation water, mm.fed^{-1}.

Re = effective rainfall, mm.fed^{-1}.

S = amount of soil moisture contributing to consumptive use either from stored moisture in root zone and / or that from shallow water table, mm.

Value of S was neglected because of the ground water table remained at a depth of a about 2 m below the surface according to observation wells installed in the field , so the upward flow into the soil profile was negligible.

. Irrigation water applied (IW):

Submerged flow orifice with fixed dimension was used to convey and measure the irrigation water applied, as the following equation **(James,1988).**

$$Q = CA\sqrt{2gh} \quad \text{..........(2)}$$

Where:

Q = Discharge through orifice, $cm^3.sec^{-1}$.
C = Coefficient of discharges, (0. 61).
A = Cross sectional area of orifice, cm^2.
g = Acceleration due to gravity, $cm.sec^{-2}$ ($980 cm.sec^{-1}$).
h = Pressure head, over the orifice center, cm.

-Water Consumptive Use (CU):

Water consumptive use was calculated using the following equation **(Hansen *et al.*, 1979).**

$$Cu = \sum_{i=1}^{1=4} D_1 \times D_{bi} \times \frac{PW_2 - PW_1}{100} \quad \text{..........(3)}$$

Where:

CU = Water consumptive use, cm.
$D1$ = Soil layer depth, cm.
Db_1 = Soil bulk density, Mg. m^{-3}.
PW_1= Soil moisture percentage before irrigation (%, d.b.).
PW_1=Soil moisture percentage, 48 hours after irrigation (%, d.b.).
I = Number of soil layers.

-Water productivity (Wp):

It was calculated according to ***Ali et al., (2007).***

$$WP = GY/ET \quad \text{..........(4)}$$

Where:

WO= (kg seeds m^{-1} *WCU);*
GY= grain yield (kg fed^{-1}*)and*
ET= total water consumption of the growing season (m^3 $fed.^{-1}$).

-Productivity of irrigation water (PIW)

Productivity of irrigation water was calculated according to **(Ali et *al.*, 2007).**

$$PIW = GY/IW \qquad (5)$$

Where:

IW = irrigation water applied, $m^3.fed.^{-1}$.

GY = root yield, $kg.fed.^{-1}$.

-Root length and diameter:

At harvest time, (190 days from sowing) random sample of ten plants, were chosen from each plot, to determine some plant parameters of sugar beet growth, (i.e. root diameter and root length (cm), as well as, root weight (Kg). Also, some characters of sugar beet roots quality have been measured and calculated such as, Sucrose % and the purity %, were measured at Delta sugar Company Limited Laboratories at Kafr El-Sheikh.

-Yield (ton fed.$^{-1}$):

The yield of the two central furrows was weighed and computed as:

(a) Root yield (ton.fed.$^{-1}$). (b) Sugar yield (ton.fed.$^{-1}$) obtained by multiplying root yield by sucrose percentage.

-Statistical analysis:

The obtained data were statistically analyzed by analysis of variance. The data of the two seasons showed nearly the same trend, Thus, combined analysis was done according to Gomez and Gomez (1984) .Means of the treatment were compared by the least significant difference (LSD) at 5% level of significance which developed by **Waller and Duncan (1969).**

RESULTS AND DISCUSSION

1- Water relations:

a- Seasonal Water applied (Wa):

Total water applied for sugar beet at different periods of drought during two growing seasons of 2008/2009 and 2009/2010 was presented in Table (2). Results indicated that the full-irrigated treatment (without drought before harvesting) received the highest total amount of irrigation water (3493 and 3480 $m^3.fed.^{-1}$) in the 1st and 2nd seasons, respectively. Increasing the period of drought before harvesting resulted in decreasing the number of applied irrigations and consequently the total applied water.

The water stressed treatment (drought period of 9 weeks before harvesting) received the lowest amount of water (2898 and 2873m^3.fed.$^{-1}$) in the 1st and 2nd seasons, respectively. The total water applied for sugar beet decreased by 17.0 and 17.4 % when the period of drought before harvesting increased from 3 to 9 weeks in the 1st and 2nd growing seasons, respectively. These results are in agreement with those obtained by **Ibrahim et al.(1993). and EL-Atawy,(2007)**

Table (2): Total water applied of sugar beet as affected by drought periods during two growing seasons of 2008/ 2009 and 2009/ 2010.

Growing seasons	Drought periods, weeks	Irrigation number									Seasonal applied water, cm	Rain, cm	Total applied water	
		planting	1st	2nd	3rd	4th	5th	6th	7th	8th			Cm	m^3.fed^{-1}
2008/2009	3 weeks	9.75	4.15	5.35	9.10	10.12	12.25	12.30	8.70	6.1	77.82	5.36	83.18	3493
	6 weeks	9.75	4.05	5.50	8.95	10.15	12.15	12.60	4.70	-	67.85	5.36	73.41	3075
	9 weeks	9.75	4.19	5.65	9.05	10.22	12.32	12.45	-	-	63.63	5.36	68.99	2898
2009/2010	3 weeks	9.75	4.25	5.55	9.06	10.10	12.50	12.65	8.30	6.2	78.36	4.50	82.86	3480
	6 weeks	9.75	4.15	5.66	9.15	10.25	12.28	12.50	7.15		70.89	4.50	75.39	3166
	9 weeks	9.75	4.10	5.60	9.20	10.30	12.60	12.36			63.91	4.50	68.41	2873

b- Water consumptive use "*CU*" in m^3 fed.$^{-1}$:

Water consumptive used of sugar beet, as influenced by the period of drought before harvesting during two growing seasons of 2008/2009 and 2009/2010 was presented in Table (3). It is clear that the *CU* has been decreased with increasing the period of drought before harvesting for two growing seasons. The full – irrigated treatment (without drought) consumed the maximum average value of seasonal CU (2372.2 and 2291.5 m^3.fed.$^{-1}$) in the 1st and 2nd seasons, respectively. While, the water stressed treatment (drought period of 9 weeks before harvesting) recorded the lowest average value of seasonal CU (1976.5 and 1938.3 m^3.fed.$^{-1}$) in the 1st and 2nd seasons, respectively. Increasing the drought period before harvesting from 3 to 9 weeks saved about 16.7 and 15.4 % in the 1st and 2nd seasons, respectively from the CU of sugar beet roots.

It was also noticed that the monthly water consumptive use was low during November (3.41cm) and increased with time to reach its maximum value (13.92cm) during April in the first season 2008/2009. These results are in agreement with those obtained by ***Ibrahim et al. (1993) and EL-Atawy, (2007).***

Table (3): Monthly and seasonal water consumptive use (cm) of sugar beet as affected by drought periods during 2008/ 2009 and 2009 /2010 growing seasons.

Drought periods, weeks	Month	Monthly water consumptive use , cm		
		2009/2008	2010/2009	Mean
3 weeks	Nov.	3.41	3.41	3.41
	Dec.	5.73	4.91	5.32
	Jan.	5.98	4.98	5.48
	Feb.	6.14	7.17	6.65
	March	11.31	11.41	11.36
	April	13.92	12.86	13.39
	May	9.99	9.82	9.91
	Seasonal	56.48	54.56	55.52
6 weeks	Nov.	3.41	3.41	3.41
	Dec.	5.70	4.76	5.23
	Jan.	6.00	7.05	6.52
	Feb.	9.11	9.08	9.10
	March	11.25	11.24	11.25
	April	10.91	10.93	10.92
	May	6.11	6.16	6.13
	Seasonal	52.49	52.63	52.53
9 weeks	Nov.	3.41	3.41	3.41
	Dec.	5.88	4.91	5.39
	Jan.	5.08	6.11	5.59
	Feb.	9.13	9.17	9.15
	March	10.52	10.50	10.51
	April	10.84	9.78	10.31
	May	2.20	2.27	2.24
	Seasonal	47.06	46.15	46.60

c- Water productivity (*WP*) and Productivity of irrigation water (*PIW*):

Water productivity (*WP*) and Productivity of irrigation water (*PIW*) for sugar beet crop, at different periods of drought before harvesting, and different rates of potassium fertilization were presented in Table (4). Water productivity determines the capability of plants to convert the consumed water to crop yield. The (*WP*) and (*PIW*) of sugar beet could be evaluated by both root and sugar yields. The data showed that the period of drought and rate of K fertilization had highly significant effect on the (*WP*) and (*PIW*) during the two growing seasons.

Results indicated that the highest average values of *PW* (15.59 and 15.46 kg root.m^{-3}) and *WIP* (10.63 and 10.43 kg root.m^{-3}) could be achieved with the water stressed treatment (drought period of 9 weeks before harvesting) during the 1st and 2nd growing seasons of 2008/2009 and

2009/2010. While, the lowest values of both (*WP*) and (*PIW*) had accomplished with the full irrigated treatment (without drought before harvesting) during two growing seasons.

The data also illustrated that, increasing the rate of K fertilization increased (*WP*) and (*PIW*) for root yield, at all the periods of drought during two growing seasons. The highest average values of *WP* (16.82 and 16.72 kg root.m^{-3}) had been achieved by fertilization rate of 72 kg $K_2O.fed.^{-1}$ during the 1st and 2nd growing seasons of 2008/2009 and 2009/2010, respectively. The interaction of irrigation regime with K fertilization had highly significant effects on (*WP*) and (*PIW*) during the two growing seasons.

Table (4): Water productivity and Irrigation water productivity of sugar beet crop (Kg. m^{-3}) as affected by drought periods and potassium fertilization rates during 2008 / 2009 and 2009/2010 growing seasons.

Drought periods before harvesting, weeks	K – fertilization rates, Kg $K_2O.fed^{-1}$	Water productivity, Kg root.m^{-3}			Irrigation water productivity, Kg sugar.m^{-3}		
		2009/2008	/2009 2010	Mean	2009/2008	/2009 2010	Mean
3 weeks before harvesting	K0	13.49	13.44	13.46	9.16	8.85	9.01
	K48	14.66	14.66	14.64	9.96	9.63	9.79
	K72	15.53	15.53	15.54	10.55	10.23	10.39
	Mean	14.56	14.56	14.55	9.89	9.57	9.73
6 weeks before harvesting	K0	13.99	13.40	13.69	10.03	9.36	9.70
	K48	15.26	14.70	14.98	10.94	10.33	10.64
	K72	16.28	15.77	16.03	11.67	11.01	11.34
	Mean	15.18	14.62	14.90	10.88	10.23	10.56
9 weeks before harvesting	K0	14.19	14.01	14.10	9.68	9.45	9.57
	K48	15.77	15.66	14.72	10.75	10.56	10.65
	K72	16.82	16.72	16.77	11.47	11.28	11.37
	Mean	15.59	15.46	.15.53	10.63	10.43	10.53
L. S. D at 5 %		0.42			0.15		
Mean of fertilization	K0	13.89	13.62	13.76	8.63	9.31	8.97
	K48	15.23	15.01	15.12	10.55	10.17	10.36
	K72	16.21	16.01	16.11	11.23	10.84	11.04

2-Sugar beet yield and quality:

a- Root and sugar yields:

Table (5) shows the root and sugar yields of sugar beet crop as affected by the period of drought and the rate of K fertilization during two growing seasons of 2008/2009 and 2009/2010. The drought treatment had highly significant effect on root and sugar yield for two growing seasons. The full-irrigated treatment (The drought period of 3 weeks before harvesting) resulted in the highest average value of root yield (33.92ton.fed.$^{-1)}$ but, the highest average value of sugar yield (6.37ton.fed.$^{-1}$) had been accomplished with the drought period of 6 weeks before harvesting. On the other hand, the lowest average value of root yield (30.4ton.fed.$^{-1}$) had been recorded with the drought period of 9 weeks before harvesting, similar results were obtained by ***Abo-Shady .et al. (2010).***

Results also indicated that potassium fertilization had highly significant effect on root and sugar yields. Increasing the rate of K fertilization resulted in increasing root and sugar yields for two growing seasons. The K fertilization rate of 72 kg K_2O.fed.$^{-1}$had achieved the highest average value of root and sugar yields 34.81 and 6.86 ton.fed.$^{-1}$, respectively .The interaction between drought periods and K fertilization had highly significant effect on root and sugar yields (35.9 and 7.41 ton.fed.$^{-1}$respectively) were obtained with application of 72 kg K_2O.fed.$^{-1}$at 6 weeks period of drought before harvesting. Similar results were also recorded by ***Edris et al., (1992) Hilal (2005) and Abo- Shady et al. (2010).***

Table (5):Root and sugar yields of sugar beet crop (ton/fed) as affected by drought periods and potassium fertilization rates during two growing seasons 2008/ 2009 and 2009/ 2010.

Drought periods before harvesting, weeks	K – fertilization rates, Kg K_2O.fed^{-}	Root yield of sugar beet, ton/fed			Gross sugar yield of sugar beet, ton		
		2009/2008	/2009 2010	Mean	2009/2008	/2009 2010	Mean
3 weeks before harvesting	K0	31.99	30.80	31.40	5.27	4.80	5.04
	K48	34.78	33.50	34.14	6.16	5.54	5.85
	K72	36.85	35.60	36.23	6.73	6.16	6.45
	Mean	34.54	33.30	33.92	6.05	5.50	5.78
6 weeks before harvesting	K0	30.85	29.62	30.24	5.63	5.30	5.47
	K48	33.65	32.70	33.18	6.37	6.08	6.23
	K72	35.90	34.85	35.387	7.41	7.10	7.26
	Mean	33.47	32.39	32.93	6.47	6.26	6.37
9 weeks before harvesting	K0	28.05	27.15	27.60	5.24	5.02	5.13
	K48	31.16	30.35	30.76	5.97	5.80	5.89
	K72	33.25	32.40	32.83	7.00	6.76	6.88
	Mean	30.82	29.97	30.40	6.07	5.86	5.97
L. S. D at 5 %		1.17			0.41		
Mean of fertilization	K0	30.30	29.19	2975	5.38	5.04	5.21
	K48	33.20	32.18	32.69	6.17	5.55	5.86
	K72	35.33	34.28	34.81	7.05	6.67	6.86

b- Sucrose percentage and juice purity:

Sucrose percentage and juice purity of sugar beet roots, under different periods of drought and different rates of k- fertilization during two growing seasons were presented in Table (6). Sucrose percentage and juice purity had significantly affected by drought periods, potassium fertilization and the interaction between them during the two growing seasons. Data revealed that sucrose percentage and juice purity were increased significantly with increasing the period of drought before harvesting. The highest average values of sucrose percentage and juice purity (19.63 and 82.82 %, respectively) could be accomplished with the water stressed treatment (drought period of 9 weeks before harvesting) during the first growing season. Increasing the rate of K fertilization resulted in increasing the sucrose percentage and juice purity during the two growing seasons. The highest average values of sucrose percentage and juice purity (19.98 and 83.28 %, respectively) were obtained with application 72 kg K_2O fed.$^{-1}$. These results were in agreement with those of ***Ibrahim et al. (2002), Isoda (2007), Hassanli et al. (2010) and Abo-Shady et. al. (2010).***

Table 6) : Sucrose percentage and Juice purity of sugar beet crop (%) as affected by drought periods and potassium fertilization rates during two growing seasons 2008/2009 and 2009/2010.

Drought periods before harvesting , weeks	K – fertilization rates , Kg $K_2O.fed^{-1}$	Sucrose percentage of sugar beet , %			Juice purity of sugar beet, %		
		2009/2008	/2009 2010	Mean	2009/2008	/2009 2010	Mean
3 weeks before harvesting	K0	16.47	15.60	16.03	80.53	65.47	73.00
	K48	17.70	16.85	17.28	81.30	66.55	73.93
	K72	18.25	17.69	17.97	82.75	67.47	75.11
	Mean	17.47	16.71	17.09	81.52	66.50	74.01
6 weeks before harvesting	K0	18.25	17.90	18.08	81.0	66.90	73.95
	K48	18.92	18.60	18.76	82.22	67.69	74.96
	K72	20.65	20.36	20.50	83.19	68.60	75.90
	Mean	19.27	18.95	19.11	82.14	67.73	74.94
9 weeks before harvesting	K0	K0	18.68	18.50	18.59	81.80	67.65
	K48	K48	19.15	19.10	19.13	82.75	68.82
	K72	K72	21.05	20.86	20.96	83.90	69.82
	Mean	Mean	19.63	19.49	19.56	82.82	68.76
L. S. D at 5 %		0.52			0.71		
Mean of fertilization	K0	17.80	17.33	17.57	81.11	76.67	78.89
	K48	18.59	18.18	18.39	82.09	77.69	79.89
	K72	19.98	19.64	19.81	83.28	78.63	80.96

c- Root length and diameter:

Data of sugar beet length and diameter, as affected by drought periods and potassium fertilization during two growing seasons are presented in Table (7). Results showed that both root length and diameter were highly significantly affected by drought periods during the two growing seasons. Data revealed that the extended periods of drought resulted in elongation of sugar beet roots. The explanation of such root elongation is that with severe depletion of soil moisture in soil surface, the plants manipulate its root by elongation to search for water in deep soil layers. The same findings were found by ***Eid (1994)***. The highest average values of root length and diameter (36.56 and 35.22 cm) and (14.90 and 14.40cm) in the 1st and 2nd growing seasons, respectively. In contrast, the full-irrigated treatment gave the shortest root length of sugar beet (33.63 and 32.31 cm) in the 1st and 2nd growing seasons, respectively.

Potassium fertilization had highly significant effect on sugar beet length and diameter during the 1st and 2nd growing seasons. Increasing the rate of K fertilization resulted in increasing the root length and diameter during the two growing seasons.

Table (7): Root length and diameter of sugar beet crop as affect by drought periods and potassium fertilization rates during two growing seasons 2008/ 2009 and 2009/ 2010.

Drought periods before harvesting, weeks	K – fertilization rates, Kg K_2O. fed.$^{-1}$	Root length of sugar beet, cm			Root diameter of sugar beet, cm		
		2008/2009	2009/ 2010	Mean	2008/2009	2009/ 2010	Mean
3 weeks before harvesting	K0	32.80	31.25	32.03	12.82	11.92	11.87
	K48	33.50	32.45	32.98	13.15	12.45	12.80
	K72	34.60	33.22	33.91	14.65	13.33	13.99
	Mean	33.63	32.31	32.97	13.54	12.57	13.06
6 weeks before harvesting	K0	33.75	32.80	33.28	13.30	12.46	12.88
	K48	34.95	33.60	34.28	14.20	13.58	13.89
	K72	36.05	34.95	35.50	14.70	13.82	14.26
	Mean	34.92	33.78	34.35	14.07	13.29	13.68
9 weeks before harvesting	K0	35.15	34.25	34.70	14.10	13.66	13.88
	K48	36.60	35.00	35.80	15.09	14.45	14.77
	K72	37.92	36.42	37.17	15. 52	15.10	1531
	Mean	36.56	35.22	35.89	14.90	14.40	14.65
L. S. D at 5 %		0.63			0.47		
Mean of k fertilization	K0	33.90	33.75	33.83	13.41	12.68	13.05
	K48	35.01	33.70	34.36	14.15	13.49	13.82
	K72	36.19	34.86	35.53	14.96	14.08	14.52

Application of 72 kg K_2O fed.$^{-1}$resulted in the highest average values (36.19 and 34.86 cm) and (14.96 and 14.08 cm) of root length and diameter in the 1st and 2nd growing seasons, respectively. Data also, indicated that the interaction between drought and potassium treatments had highly significant effect on root length and diameter during the two growing seasons. These results were in agreement with those of ***Eid (1994), Ibrahim et al. (2002), Isoda (2007), Hassanli et al.(2010) and Abo- Shady et al. (2010).***

CONCLUSION

It could be recommended that application of 72 kg K_2O fed.$^{-1}$ and withholding the last irrigation at 6 weeks before harvesting at North Delta achieved the highest yield and quality for sugar beet crop, saving about 12% of applied irrigation water.

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الملخص العربي

تأثير فترات الحرمان (الجفاف) والتسميد البوتاسي على العلاقات المائية وانتاجية محصول بنجر السكر في شمال الدلتا

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أجرى هذا البحث بالمزرعة البحثية بمحطة بحوث إدارة المياه بالقرضا محافظة والتي تمثل- شمال الدلتا خلال الموسمين الزراعيين كفر الشيخ ٢٠٠٨ / ٢٠٠٩ و ٢٠٠٩ / ٢٠١٠ لدراسة تأثير الجفاف قبل الحصاد والتسميد البوتاسي على بعض العلاقات المائية ، مثل الاستهلاك المائي والكفاءة الاستعمالية لماء الري) وإنتاج ونوعية محصول بنجر السكر في شمال الدلتا لإيجاد أنسب معدل للتسميد البوتاسي تحت ظروف الجفاف للحفاظ على امثل إنتاج ونوعية لبنجر السكر وقد صممت التجربة بنظام القطاعات المنشقة في أربع مكررات وكانت معاملات التجربة:

١- فترة الجفاف قبل الحصاد

A- ٣ أسابيع   B- ٦ أسابيع   C - ٩ أسابيع

٢- معدل التسميد البوتاسي

١- بدون تسميد   ٢ – ٤٨ كجم K_2O / فدان   ٣- ٧٢ كجم K_2O / فدان

وكانت أهم نتائج الدراسة :-

١- أوضحت النتائج أن أعلي قيمة متوسطة لكفاءة انتاجية المتر المكعب من مياه الري المستهلكة بواسطة نباتات بنجر السكر (١٣،٩٣كجم جذورلكل متر مكعب ماء مستهلك) وكذلك الكفاءة الانتاجيةلمياه الرى المضافة(٩،٩٣كجم جذور لكل متر مكعب ماء مضاف) بالاضافة الى نسبة السكر(٢٠،٩٥%)قد تم الحصول عليها مع معاملة الحرمان من الرى قبل الحصاد ب٩أسابيع، بينما حققت معاملةالحرمان من الرى قبل الحصاد(الجفاف) ب٦أسابيع أعلى قيمة متوسطة لأنتاجية السكر(٧،٢٦ طن سكر/فدان لموسمى الزراعة.

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٢- أظهرت النتائج عدم وجود فروق معنوية في محصول بنجر السكر من الجذور والسكر، طول و قطر الجذر، نسبة السكر ونقاوته، كفاءة انتاجية مياه الرى المستهلكة والكفاءة الانتاجية لمياه الرى المضافة بينمعاملات التسميد المختلفةخلال موسمى الزراعة وأن التسميد البوتاسى يعوض النقص فى محصول بنجر السكر الناتج عن الحرمان من الرى(الجفاف) لفترات طويلة قبل الحصاد.

٣- حقق التسميد البوتاسى بمعدل ٧٢ كجم K_2O /فدان أعلى القيم لانتاجية الجذور (٣٦,٨٥، ٣٥,٦٠ طن / فدان) ، إنتاجية السكر (٧,٤١ ، ٧,١٠ طن /فدان)، النسبة المئوية للسكر (٢١,٠٥ ، ٢٠,٨٦%) ، درجة النقاوة (٨٣،٩٠ ، ٦٩،٨٢ %) ، طول الجذر (٣٦،١٩ ، ٣٤،٨٦ سم) ، قطر الجذر (١٤،٩٦ ، ١٤،٠٨ سم) ، WP(١٤،١٢ ، ١٣،٧٢كجم جذور /م٣) ، WIP (١٠،٠٢ ، ٩،٨٤ كجم جذور/م٣) لمحصول بنجر السكر خلال موسمي النمو ٢٠٠٨/٢٠٠٩ ، ٢٠٠٩/٢٠١٠ على التوالى .

٤- توصى الدراسة باضافة سماد بوتاسى بمعدل ٧٢ كجم K_2O /فدان مع حرمانه من الري قبل الحصاد بـ ٦ أسابيع في أراضي شمال الدلتا للحصول على أعلى إنتاجية لمحصول بنجر السكر مع توفير حوالي ١٦ % من مياه الري المضافة والحفاظ على التربة من القلوية والملوحة.