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Tolerance of Some Sugar Beet Cultivars to Soil Salinity

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TWO FIELD experiment were conducted at the experimental farm of Sakha Agric. Res . Station during two successive seasons 1996/97 and 1997/98. The objective of this investigation was to study the effect of four ranges of Soil salinity; 8-12, 12-16, 16-20 and 20-25 dS/m under field conditions, on yield and quality of four sugar beet varieties; Ras Poly, Kawemira, Maribo and Dobreah local (Syrian cultivar). The experiments were conducted in split-plot design with four replicates.

The obtained results can be summarized as follows :

* The root yield of sugar beet cultivars was affected significantly by the different ranges of soil salinity.
*The highest values of root yield in the two seasons were generally obtained from Dobreah local (Syrian cultivar) under all soil salinity ranges.
*Sucrose percentage of sugar beet cultivars were significantly affected by soil salinity ranges in the first season. Sucrose percentage was significantly affected with sugar beet cultivars in both seasons.
*Maribo and Kawemira cultivars generally gave the highest values of sucrose % under different ranges of soil salinity in the both seasons.

In general, the data indicate that Dobreah local (Syrian cultivar) gave, under the experimental conditions, the highest values of root yield in the two seasons under higher ranges of soil salinity and gross sugar yield.

Keywords: Soil salinity, sugar beet, sucrose.

Soil salinity is the most important environmental factor influencing the agricultural productivity, especially in arid and semi-arid regions as in Egypt. The management of salt affected soils require a good understanding of crop

salinity relations and particularly under field conditions. Sugar beet has become an important crop for sugar production in Nile Delta where it can be grown in new cultivated area located in the northern regions. Kafr El-Sheikh Governorate is the main area for sugar beet cultivation representing about 78% of the total national cultivated area. Mass (1986) tabulated a number of economic crops according to their tolerance to salt concentration. He stated that sugar beet crop is a tolerant one. El-Hawary (1994) found that increasing soil salinity ranges decreased significantly root and sugar yields of sugar beet per feddan. Zein *et al.* (1998) found that yield and quality of sugar beet cultivars were significantly affected by soil salinity up to 10 dS/m. Plaster (1992) found that sugar beet can stand a level of soil salinity up to ECe 8-16 dS/m and ESP 4-60.

The objective of the current work is to study the effect of four ranges of soil salinity under field conditions on yield and quality of four sugar beet varieties.

Material and Methods

Two field experiments were conducted at the experimental farm of Sakha Agriculture Research Station, Kafr El-Sheikh Governorate during two successive seasons (1996/97 and 1997/98). The objective of this work aimed at studying the effect of four ranges of soil salinity (S_1) 8-12, (S_2) 12-16, (S_3) 16-20 and (S_4) 20-25 dS/m under field conditions on yield and quality of four sugar beet varieties: Ras Poly, Kawemira, Maribo and Dobreah local (Syrian cultivar).

The experiments were conducted in a split-plot design with four replicates. The main plots were assigned to soil salinity treatments. Sugar beet cultivars occupied the sub-plots. The area of each plot was 4 x 2.5 = 10 square meter. All plots of the experiment were treated with 35.9 kg P_2O_5/ha (super phosphate 15.5% P_2O_5). Nitrogen fertilizer at the rate of 167 kg/h (urea 46% N) was splitted in two equal doses. The first dose was added at thinning (after 40 days from sowing) and the second dose was added after 30 days later. The K fertilizer at the date of 114.0 kg K_2O/ha (K_2SO_4; 48% K_2O) was applied after 40 days from sowing. Three seeds were sown in each hill; 20 cm between hills. Seeds were sown on the 15th and the 13th of Nov., 1996 and 1997, respectively. Plants were thinned to one plant per hill after 40 days from sowing. The sugar beet was harvested in 1st June of the two seasons. Representative samples of sugar beet roots were taken at the time of harvesting to determine sugar beet constituents, *i.e.* sucrose %, white sucrose %, and purity %. These parameters were determined polarimetrically by means of an automatic sugar polarimeter as

described by McGinnus (1971) and gross sugar yield (ton/ha) was calculated from root yield (ton/ha) x sucrose %.

The chemical analysis of Nile water used for irrigation during studied seasons were as follows; 0.43 dS/m, 3.54, 0.94, 0.87, 1.68, 1.6, 1.76 and 0.22 meq/L for HCO_3^-, CL^-, $SO_4^=$, Ca^{++}, Mg^{++}, Na^+ and K^+, respectively. The irrigation water schedule for the two experiments are presented in Table 1 .

TABLE 1 .The irrigation water schedule from planting to harvesting for all plots of the experiments.

Irrigation	1996/97		1997/98	
	Date of irrigation	Period	Date of irrigation	Period
Planting	15/11/1996	40	13/11/1997	41
First	25/12/1996	31	24/12/1997	31
Second	25/1/1997	35	24/1/1997	36
Third	1/3/1997	17	1/3/1998	15
Fourth	18/3/1997	21	16/3/1998	16
Fifth	10/4/1997	20	1/4/1998	15
Sixth	30/4/1997	15	16/4/1998	20
Seventh	15/5/1997	16	6/5/1998	25
Harvesting	1/6/1997	195	1/6/1998	199

Data were statistically processed according to Snedecor and Cochran (1980).

Some soil properties of the two experimental sites are presented in Table 2. The soil salinity (ECe) dS/m, soluble cations and anions me/L and sodium adsorption ratio (SAR) at the studied locations are presented in Table 3. The meteorological data supplied by Sakha Climatological Station are listed in Table 4. Soil Type was typic ustorthent.

TABLE 2 . Some chemical and physical properties of the soil surface layer (0-30 cm) of the experimental locations.

Distance from soil surface (cm)	Mechanical analysis			Texture	Chemical analysis											
					1996/97						1997/98					
	Clay %	Silt %	Sand %		Soil pH (1: 2.5)	O.M %	Total carbonate %	Available nutrients g/kg			Soil pH (1: 2.5)	O.M %	Total carbonate %	Available nutrients mg/kg		
								N	P	K				N	P	K
0-30	51.49	24.85	23.66	Clay	7.9	1.5	2.5	20	12	500	7.8	1.70	2.5	24	10	550

TABLE 3 . Soil salinity (ECe) dS/m, soluble cations and anions meq/L and sodium adsorption ratio (SAR) of the experimental locations.

Salinity ranges dS/m	ECe dS/m 25°C	Anions (meq/L)				Cations (meq/L)				SAR
		CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^+	K^+	
1996/1997 Season										
S_1 (8-12)	10.0	2.0	4.0	46.4	47.6	35.7	21.9	42.2	0.20	7.8
S_2 (12-16)	14.0	3.0	6.5	92.8	37.7	25.5	56.1	58.1	0.30	9.1
S_3 (16-20)	17.0	3.0	10.5	109.2	30.3	45.5	41.7	82.6	0.20	14.2
S_4 (20-25)	22.0	3.0	1.5	150.8	64.7	45.9	46.9	126.6	0.60	18.6
1997/1998 Season										
S_1 (8-12)	11.0	2.0	4.5	69.6	33.9	30.6	31.8	37.5	0.10	6.7
S_2 (12-16)	13.0	3.0	3.0	81.2	42.8	45.9	30.9	52.9	0.30	8.5
S_3 (16-20)	17.0	2.0	3.5	139.2	25.3	40.8	55.2	73.7	0.35	10.7
S_4 (20-25)	21.0	2.0	5.0	162.4	40.6	51.0	49.8	108.6	0.60	15.3

TABLE 4 . Meteorological data supplied by Sakha Climatological Station during 1996/97 and 1997/98 seasons.

Season	Month	Temp* C°	R.H.** %	E.T. cm/day	Rain fall cm/month
1996/97	Dec.	14.8	76.0	0.211	0.04
	Jan.	12.3	58.5	0.250	1.50
	Feb.	12.3	63.5	0.270	1.60
	Mar.	13.2	55.0	0.340	0.13
	Apr.	15.3	50.5	0.488	1.15
	May	21.0	50.7	0766	-
1997/98	Dec.	14.8	63.3	0.211	-
	Jan.	11.4	66.0	0.254	-
	Feb.	13.2	66.0	0.234	2.7
	Mar.	13.7	59.4	0.326	1.5
	Apr.	18.5	62.4	-	-
	May	22.5	59.0	-	0.5

* Mean monthly temperature in °C.

** Mean monthly relative humidity in percentage.

There were no substantial differences between the meteorological data during the two seasons.

Results and Discussion

1.Yield of sugar beet cultivars as affected by soil salinity ranges

Root yield

The results in Table 5 and Fig. 1 showed that root yield of sugar beet was affected significantly by soil salinity ranges and with sugar beet varieties. The maximum values of root yield (61.44 and 58.80 ton/ha in 1997 and 1998) were obtained under S_1 soil salinity range, while the lowest values of root yield (30.17 and 26.10 ton/ha in 1997 and 1998) were obtained under S_2 and S_4 soil salinity ranges in 1997 and 1998 and with Ras Poly cultivar. In general, it could be stated that Dobreah local cultivar gave the highest gross sugar and root yields, while Ras Poly gave the lowest significant ones in both years.

TABLE 5. Effect of soil salinity ranges on root and shoot yields of four sugar beet cultivars (ton/ha) in seasons 1996/97 and 1997/98.

Sugar beet varieties	Soil salinity ranges (dS/m)									
	First season (1996/97)					Second season (1997/98)				
	S_1 (8-12)	S_2 (12-16)	S_3 (16-20)	S_4 (20-25)	Mean	S_1 (8-12)	S_2 (12-16)	S_3 (16-20)	S_4 (20-25)	Mean
	Root yield (ton/ha)									
Ras Poly	39.6 c	30.11 d	39.15 c	35.2 c	36.04 c	48.91 b	39.39 b	37.43 d	26.1 c	37.95 b
Kawemira	50.88 b	48.64 b	50.26 b	43.15 b	48.23 b	48.61 b	52.29 a	53.99 b	45.95 a	50.21 a
Maribo	50.14 b	41.93 c	51.68 b	42.36 b	46.53 b	40.84 c	36.69 c	44.86 c	37.72 b	40.05 b
Dobreah local	61.44 a	56.81 a	60.60 a	52.63 a	51.87 a	58.82 a	41.44 b	56.09 a	46.09 a	50.77 a
Statistical Analysis	S		V		S X V	S		V		S X V
LSD 5%	4.64		3.76		*	2.84		2.68		*
LSD 1%	6.43		5.04		ns	3.91		3.59		**
C.V. %	8.7%		5.5%			4.7%		4.2%		
	Shoot yield (ton/ha)									
Ras Poly	25.84 d	28.39 b	19.67 b	24.49 b	24.59	20.19 d	21.52 c	22.71 b	24.13 c	22.14 b
Kawemira	34.11 c	37.66 a	35.44 a	34.5 a	35.42	26.68 b	22.61 c	29.93 a	30.29 b	27.39 a
Maribo	39.27 b	29.62 b	34.31 a	34.8 a	34.67	31.31 a	31.92 a	28.35 a	30.46 b	30.51 a
Dobreah local	45.28 a	35.78 a	38.31 a	25.43 b	36.20	24.25 c	25.29 b	30.23 a	33.76 a	28.38 a
Statistical Analysis	S		V		S X V	S		V		S X V
LSD 5%	3.74		3.61		*	2.1		1.9		*
LSD 1%	5.12		4.84		**	2.89		2.54		**
C.V. %	7.9%		7.7%			6.1%		4.9%		

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

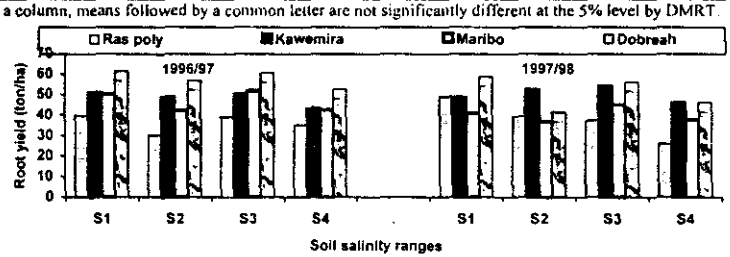

Fig. 1.Effect of soil salinity ranges on root yield of sugar beet cultivars in the two studied seasons.

These results were supported by the data obtained by Zein *et al.* (1998) who concluded that Dobreah local cultivar tolerates soil salinity (ECe) ranged from 2-10 dS/m than the other studied cultivars under field conditions.

The interaction between soil salinity ranges and sugar beet cultivars were significant in 1997 and highly significant in 1998.

The mean values of root yield of sugar beet cultivars as affected by different soil salinity ranges over the two seasons were in the order: Dobreah local (Syrian) > Kawemira > Maribo > Ras Poly. These results indicate that root yield of sugar beet cultivars were affected significantly by soil salinity. It could be stated that Dobreah local cultivar tolerates soil salinity more than the other studied cultivars while Ras Poly cultivar is more negatively affected by soil salinity under field conditions. It is common that field crops differ greatly in their response to salinity levels and the differences in salt tolerance often occur between different cultivars of a given species (Jefferies, 1988).

Shoot yield

Data in Table 5 showed that shoot yield of sugar beet cultivars were affected significantly by soil salinity ranges and with sugar beet varieties. The interaction between soil salinity ranges and sugar beet cultivars were significant over the two seasons.

The highest values of shoot yield of sugar beet (45.28 and 33.76 ton/ha in 1997 and 1998) were obtained under S_1 and S_4 soil salinity in 1997 and 1998 and with Dobreah local (Syrian cultivar) in the two seasons, while Ras Poly cultivar gave the lowest value of shoot yield. In general, it is important to note that Dobreah local cultivar gave the highest values of root and shoot yields while Ras Poly cultivar gave the lowest values of root and shoot yields under different soil salinity ranges. These results indicate that root and shoot yields of Dobreah local cultivar is more tolerant to soil salinity (ECe) range from 8-25 dS/m than the other studied cultivars under field conditions. While Ras Poly cultivar was more sensitive to soil salinity within the same range. The observed results indicate that there were balance between the root and shoot yields of Dobreah local and Kawemira varieties. These results are in agreement with those obtained by Allam and Ali (1982) and El-Yamani (1999).

2.Yield quality of sugar beet cultivars as affected by soil salinity ranges

Sucrose percentage

The obtained results (Table 6) show that sucrose percentage was affected

significantly by soil salinity ranges in 1996/1997 and with sugar beet cultivars in the two seasons, 1996/97 and 1997/98.

The interaction between soil salinity ranges and sugar beet cultivars had no significant effect on sucrose percentage in the two seasons. The maximum values of sucrose percentage (14.36 and 14.26% in 1996/97 and 1997/98) were obtained under S_4 and S_2 soil salinity in 1996/97 and 1997/98 with Maribo and Dobreah local (Syrian cultivar), respectively. Data reveal, also, that the mean value of sucrose % in 1997 was affected by soil salinity ranges were in the order: Maribo > Kawemira> Dobreah local > Ras Poly, while in 1998 the mean value were in the order: Dobreah local > Kawemira> Maribo > Ras Poly. These results indicate that sucrose % of Ras Poly cultivar was more sensitive to soil salinity than the other cultivars under studied condition. The reduction in values of sucrose % for tested sugar beet cultivars under soil salinity conditions may be due to increasing Na concentration or decreasing K/Na ratio by increasing N uptake or by other means, increase the root water concentration and reduces the sucrose concentration, (Carter, 1986). Similar results were reported by Higazy *et al.* (1994) who found that root yield quality of sugar beet cultivars differed in their response to soil salinity.

Gross sugar yield

The results in Table 6 and Fig. 2 show also that gross sugar yield was affected significantly by soil salinity ranges in the second season and by sugar beet cultivars in the two seasons.

TABLE 6. Effect of soil salinity ranges on sucrose percentage and gross sugar yield of four sugar beet cultivars in seasons 1996/97 and 1997/98.

Sugar beet varieties	Soil salinity ranges (dS/m)									
	First season (1996/97)					Second season (1997/98)				
	S_1 (8-12)	S_2 (12-16)	S_3 (16-20)	S_4 (20-25)	Mean	S_1 (8-12)	S_2 (12-16)	S_3 (16-20)	S_4 (20-25)	Mean
	Root yield (ton/ha)									
Ras Poly	11.73 b	12.93 a	11.62 a	12.88 b	12.29 c	12.52 a	12.72 a	12.41 a	12.15 a	12.45 a
Kawemira	12.38 ab	13.05 a	12.09 a	14.18 a	12.92 ab	13.73 a	13.88 a	13.51 a	13.26 a	13.59 a
Maribo	12.60 a	13.38 a	11.81 a	14.36 a	13.04 a	12.34 a	14.01 a	13.41 a	13.31 a	13.26 a
Dobreah local	11.84 ab	12.74 a	11.70 a	13.96 a	12.56 bc	13.11 a	14.26 a	14.01 a	13.59 a	13.74 a

Statistical Analysis	S	V	S X V	S	V	S X V
LSD 5%	1.00	0.80	ns	ns	1.15	ns
LSD 1%	1.39	1.08	ns	ns	1.54	ns

	Gross sugar yield (ton/ha)									
Ras Poly	4.65 c	3.90 d	4.55 c	4.54 c	4.41 c	6.13 b	5.41 b	4.62 c	3.42 c	4.89 c
Kawemira	6.30 b	6.35 b	6.56 b	6.17 b	6.34 b	6.19 b	7.26 a	7.57 a	6.55 a	6.89 a
Maribo	6.32 b	5.61 c	6.11 b	6.05 b	6.02 b	5.08 c	4.96 c	6.02 b	5.29 b	5.33 b
Dobreah local	7.28 a	7.24 a	7.09 a	7.35 a	7.24 a	7.14 a	5.49 b	7.55 a	6.29 a	6.61 a

Statistical Analysis	S	V	S X V	S	V	S X V
LSD 5%	ns	0.48	ns	0.38	0.36	*
LSD 1%	ns	0.64	ns	0.52	0.48	**

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

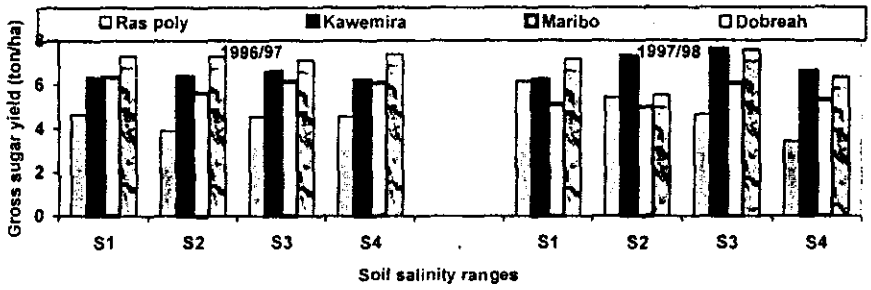

Fig. 2. Effect of soil salinity ranges on gross sugar yield of sugar beet varieties.

Data also show that the interaction between soil salinity ranges and sugar beet cultivars had no significant effect on gross sugar yield in the first season, but a significant effect was observed in the second season. The results also show that Dobreah local (Syrian cultivar) gave the maximum values of gross sugar yield under all soil salinity ranges in the first season, while in the second seasons Dobreah local and Kawemira cultivars gave the maximum values of gross sugar yield. The mean value of gross sugar yield under all soil salinity ranges with two year experiment were in the order: Dobreah local (Syrian) > Kawemira > Maribo > Ras Poly in 1996/97 season and Kawemira > Dobreah (local Syrian cultivar), Maribo > Ras Poly in 1997/98 season.

These results are in agreement with those obtained by Zein *et al.* (1998) who found that gross sugar yield of sugar beet cultivars were significantly affected by soil salinity.

White sucrose percentage

White sucrose % is an important parameter of sugar beet because it is final useful form of sugar that the consumer uses.

Data in Table 7 show that the white sucrose % was affected significantly by soil salinity ranges and with sugar beet cultivars in the first season, but it was not affected significantly by soil salinity ranges and with sugar beet cultivars in the second season. The interaction between soil salinity ranges and sugar beet cultivars had no significant effect on white sucrose % in the two years experiment. The maximum values of white sucrose % (8.07 and 8.75% in 1996/97 and 1997/98) were obtained under S_4 and S_2 soil salinity in 1996/97 and 1997/98 with Maribo and Kawemira varieties, respectively. These results are in agreement with those obtained by Khalifa and Header (1995).

TABLE 7. Effect of soil salinity ranges on white sucrose (%) and purity % of four sugar beet cultivars in seasons 1996/97 and 1997/98.

Sugar beet varieties	Soil salinity ranges (dS/m)									
	First season (1996/97)					Second season (1997/98)				
	S_1 (8-12)	S_2 (12-16)	S_3 (16-20)	S_4 (20-25)	Mean	S_1 (8-12)	S_2 (12-16)	S_3 (16-20)	S_4 (20-25)	Mean
	White sucrose %									
Ras Poly	5.96 b	6.91 a	5.86 a	6.73 b	6.38 b	7.53 a	8.22 a	6.37 a	6.94 a	7.26 a
Kawemira	6.61 ab	7.46 a	6.06 a	7.80 a	6.98 a	6.63 a	8.75 a	8.01 a	8.03 a	7.86 a
Maribo	7.00 a	7.56 a	5.49 a	8.07 a	7.03 a	6.49 a	7.91 a	7.45 a	7.95 a	7.45 a
Dobreah local	6.29 ab	5.88 b	5.43 a	7.56 ab	6.29 b	6.24 a	8.59 a	7.65 a	7.33 a	7.45 a
Statistical Analysis	S		V		S X V	S		V		S X V
LSD 5%	1.18		0.89		ns	ns		ns		ns
LSD 1%	1.64		1.19		ns	ns		ns		ns
	Purity %									
Ras Poly	50.80 a	53.38 a	49.85 a	51.61 a	51.41 a	53.75 a	57.58 a	51.70 a	52.55 a	53.89 a
Kawemira	51.15 a	56.43 a	50.15 a	52.39 a	52.53 a	51.80 a	62.83 a	54.63 a	56.20 a	56.36 a
Maribo	55.50 a	57.15 a	46.98 a	56.98 a	54.15 a	51.80 a	57.78 a	55.54 a	57.23 a	55.58 a
Dobreah local	52.65 a	43.38 b	47.48 a	53.96 a	49.36 a	51.38 a	65.23 a	58.96 a	53.83 a	57.35 a
Statistical Analysis	S		V		S X V	S		V		S X V
LSD 5%	5.84		5.53		*	ns		ns		ns
LSD 1%	ns		ns		**	ns		ns		ns

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Data also show that the mean value of white sucrose % of sugar beet cultivars under salinity levels in 1996/97 were in the order: Maribo > Kawemira > Ras Poly > Dobreah local (Syrian cultivar) with significantly differences between both Maribo and Kawemira and the two other varieties. Salinity may also affect crop quality. In sugar beet, very low levels of sugar may result.

Purity %

The results in Table 7 show that purity % was affected significantly by soil salinity ranges and with sugar beet cultivars in 1996/97, but it was not affected significantly by soil salinity ranges and with sugar beet cultivars in 1997/98.

The interaction between soil salinity ranges and sugar beet cultivars had a significant effect on purity % in 1996/97, but it had no significant effect in 1997/98.

The maximum values of purity % (57.15 and 65.23% in 1996/97 and 1997/98) were obtained under S_2 soil salinity in the two seasons with Maribo and Kawemira varieties, respectively. These results are in agreement with those reported by Khalifa and Header (1995).

In general the results indicate that Dobreah local cultivar (Syrian cultivar) tolerates than the other studied sugar beet cultivars under field conditions of the experiments. It gave generally the maximum values of root and gross sugar yields in the two years. These observation are in agreement with those reported by Zein *et al.* (1998) who found that Dobreah local (Syrian cultivar) tolerates to soil salinity (ECe) ranged from 2-10 dS/m than the other studied cultivars under field conditions.

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مقاومة بعض أصناف بنجر السكر للملوحة الارضية

فاروق إبراهيم زين ، محمد صابر اليمانى ، أحمد طاهر مصطفى
ومحمد أنور الأباصيرى

مركز البحوث الزراعية - معهد بحوث الأراضى والمياه والبيئة - الجيزة - مصر .

أجريت تجربتين حقليتين فى المزرعة البحثية (محطة البحوث الزراعية بسخا) خلال موسمين متتاليين ١٩٩٧/٩٦ ، ٨٧ / ١٩٩٨ . الهدف من البحث دراسة تأثير أربع مستويات من الملوحة الارضية (٨-١٢) ، (١٢ -١٦)، (١٦ -٢٠) ، (٢٠-٢٥) dS/m تحت ظروف الحقل على المحصول وجودتة لاربع اصناف بنجر السكر : راس بولى ، كاواميرا ، ماريبو ودبريه (صنف سورى) . أقيمت التجارب فى تصميم قطع منشقة مع اربعة مكررات .

ويمكن تلخيص النتائج المتحصل عليها كما يلى :

*تأثر محصول الجذور الاصناف بنجر السكر معنويا بمستويات الملوحة الارضية المختلفة .

* أعطى الصنف دبرية محلى (صنف سورى) اعلى قيمة لمحصول الجذور تحت جميع مستويات الملوحة الارضية عموما خلال عامى الدراسة .

* تأثرت النسبة المئوية للسكروز فى بنجر السكر خلال عامى الدراسة .

* النسبة المئوية للسكروز لاصناف بنجر السكر تأثرت معنويا بمستويات الملوحة الارضية فى الموسم الاول.

* أعطى الصنف ماريبو والصنف كاوميرا عموما اعلى قيمة للنسبة المئوية للسكروز تحت مختلف مستويات الملوحة الارضية خلال عامى الدراسة .

عموما توضح النتائج ان الصنف دبرية محلى (صنف سورى) اعطى تحت ظروف التجربة اعلى قيمة لمحصول الجذور خلال عامى الدراسة تحت جميع مستويات الملوحة الارضية وأيضا أعلى قيمة محصول سكر خام تحت ظروف التجربة .