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BROAD-SENSE HERITABILITY AND PERFORMANCE OF TEN SUGAR BEET VARIETIES FOR GROWTH, YIELD AND JUICE QUALITY UNDER DIFFERENT SOIL SALINITY LEVELS

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ABSTRACT

Soil salinity in Egypt. affects plant production, including sugar beet especially in Al-Fayoum Governorate. Screening for salinity tolerant varieties is one of the most often methods used by breeders of sugar beet. The present investigation was carried out at Al-Fayoum Governorate, (29°17` N; 30°53` E), Egypt, during 2017/2018 and 2018/2019 growing seasons. The objective was to study the effect of saline soil in three locations (villages), namely S^1, (3.57 dSm^{-1}) Monshat Sinnuris, S^2, (8.6 dSm^{-1}) Monshat bani Othman, and S^3, (11.84 dSm^{-1}) Monshat Tantawy, on plant growth, quality and yield traits of ten multigerm sugar beet varieties. The experimental design was a randomized complete blocks with three replications. The results showed that root yield and sugar yield, as well as root dimensions significantly decreased by increasing soil salinity levels as compared with the control treatment. Under severe soil salinity, Florima cultivar was superior in root and sugar yields (13.71 and 1.82 ton/fed.). respectively. On the other hand, Euklid cultivar recorded the least values (11.38 and 1.39 ton/fed), respectively**.** As for the interaction between soil salinity levels and sugar beet varieties, the highest values for root and sugar yields were recorded by the varieties Florima, Toro, Cleopatra , Tarbelli , which were cultivated under severe soil salinity (11.84 dSm^{-1}). The results recommended the above four varieties to be cultivated by farmers under saline soil. These varieties are tolerant to soil salinity and they can produce a stable root and sugar yields in the stressed soil. Heritability of metric traits is of great significance to the breeders as its magnitude indicated the accuracy with which a variety can be recognized by its phenotypic expression and determines the generation in which selection can be profitable. The results showed that five varieties had a salinity susceptibility index (SSI) based on root and sugar yields <1 and were relatively tolerant to salinity stress.

Key words: *Performance, sugar beet (Beta vulgaris L.), varieties, soil salinity, yield, quality.*

1. INTRODUCTION

Sugar beet (*Beta vulgaris* L.) is cultivated in Al-Fayoum Governorate in an area of about 35.2 thousand feddan (fed=0.42 ha) and is dominated by a low percentage in the city of Sinnuris. Most of the lands in the city of Sinnuris are affected by salinity and located around Lake Qaroun in large areas connected to most of the villages of the city, such as Monshat bani Othman, Monshat Tantawy and Monshat Sinnuris. In these villages the soil salinity ranges from 4 dSm^{-1} to 16 dSm^{-1} and has a significant impact on the growth of agricultural crops and reduces agricultural production in general (Report No. 235 "taxonomic inventory of land for the city of Sinnuris" March 1981). Soil salinity is a part of natural ecosystems under arid and semi-arid conditions (Pathak and Rao, 1998), and is an increasing problem in agricultural soils throughout the world (Qadir *et al*., 2000). Egypt is one of the countries that suffer from severe salinity problems. For example, 33% of the cultivated land, which comprises only 4% of total land area in Egypt, are already salinized due to low precipitation (< 25mm annual rainfall) and irrigation with saline water (El-Hendawy *et al*., 2004 and Abdel-Latef 2005). Salinity stress is a primary cause of crop loss worldwide reducing average yields for most of major crop plants by more than 50 % (Bray *et al.,* 2000). Plant growth is suppressed severely at high salinity stress due to factors such as osmotic stress, mineral nutrition absorption imbalance, and specific ion toxicity, all combining to reduce nutrient uptake consequentially causing physiological drought to plants (Yusuf *et al.*, 2007). However, during early growth stages of sugar beet, the earth electric conductivity (ECe) should not exceed 3 dSm^{-1} (Steduto *et al.*, 2012).

Egyptian Government imports about 1.14 million tons of sugar, every year to face the rapid increase of population, because the total sugar production is about 2.16 million ton and the total consumption is about 3.3 million ton (Annual Report of Sugar Crops Council, 2019). Sugar beet plays a prominent role in sugar production, about 57.7% of the local sugar production, which amounted to 1.25 million ton, is produced from sugar beet, which is considered the second sugar crop after sugarcane. Sugar beet has been an important crop in crop rotation as a winter crop both in poor and fertile soils. Sugar beet seeds are imported and hence beet varieties should be evaluated under the Egyptian conditions to select the best varieties in respect to yield and quality traits. The government encourages sugar beet growers to increase the cultivated area with sugar beet for decreasing the gap between sugar production and consumption. Improvement of sugar beet production can be achieved through optimizing the cultural practices.

Genetic improvement of sugar beet depends on the presence of the magnitude of genetic variability and the extent to which the desirable traits are transmissible. Heritability plays a predictive role in breeding, expressing the reliability of phenotype as a guide to its breeding value. Johnson *et al.* (1955) indicated that high heritability is not always associated with high genetic gain. Quantitative traits present particular difficulty in selection programs because heritable variations are often masked by non-heritable variations. The utility of heritability estimates increased when they are used in conjunction with genetic advance expressed as a percentage of the mean (Allard, 1960). In addition, the availability of information on the extent to which variation in individual plant character is transmitted to the next generation is also important to speed up the process of screening the breeding population in order to look for a plant having greater yield potential. The objectives of the present study were (1) to assess the effect of soil salinity levels on growth, yield and quality of ten sugar beet varieties, (2) to determine the varieties with high stable root and sugar yields, and (3) to estimate the broad-sense heritability for yield and its components.

2. MATERIALS AND METHODS

The investigation was carried out at Al-Fayoum Governorate, (29°17` N; 30°53` E), Egypt, to study the effect of saline soil of three locations S^1,3.57 dSm^{-1} (Monshat Sinnuris) , S^2 ,8.6 dSm^{-1} (Monshat bani Othman), and S^3,11.84 dSm^{-1} (Monshat Tantawy), on plant growth, quality and yield traits of ten multigerm sugar beet varieties Table (1) during the two successive winter seasons of 2017-2018 and 2018-2019. The experimental design was a randomized complete block design (RCBD) in three replications. Each experimental basic unit included 5 rows, 60 cm apart and 5 m long, comprising an area of 15 m^2. Experiments were sown on September 25*th* and 21*th* in the first and the second seasons, respectively.

The experimental soil samples were collected from two successive mixed depths (0-30 cm) and (30- 60 cm) from soil surface before cultivation to determine some physical and chemical properties of soil according to Black *et al*.

Table (1): Origin and seed type of the studied sugar beet varieties.

No.	Varieties	Type of Seeds	Origin	
			Company	Country
1	Tarbelli	Multigerm	Semences	France
2	Pleno	Multigerm	Ses	Germany
3	Farida	Multigerm	Ses	Germany
4	Florima	Multigerm	Desprez	France
5	Cleopatra	Multigerm	Desprez	France
6	Dlamand	Multigerm	Ses	Germany
7	Toro	Multigerm	Strube	Germany
8	Capel	Multigerm	Desprez	France
9	Almas	Multigerm	Strube	Germany
10	Euklid	Multigerm	Strube	Germany

Source: Sugar Crops Research Institute, ARC, Egypt

(1965) and Jackson (1973) . The soil description is given in Table (2). The fertilizers, surface irrigation and all other agronomic practices were applied as recommended at the three locations. Each treatment was irrigated by normal water from Yussef Lake, where the chemical composition of the used water is given in Table (3).

At harvest, the three guarded central rows of each plot per variety in the three locations were harvested to estimate the following traits from random five plants:

2.1. Growth traits

2.1.1. Root length (cm), Root diameter (cm), Root fresh weight/plant (kg), and Top weight/plant (kg).

2.2. Productivity traits

2.2.1. Root yield (ton/fed): calculated from root weight of experimental unit.

2.2.2. Top yield (ton/fed): calculated from top weight of experimental unit.

2.2.3. Sugar yield (ton/fed): calculated according to the following equation:

Sugar yield (ton/fed) = extractable sugar% x root yield (ton/fed)/100

2.2.4. Harvest index (HI) : it was estimated by using the following equation:

HI =Root yield (ton/fed)/ (root yield (ton/fed) + top yield (ton/fed)) ×100

2.3. Quality traits

Quality traits were determined in Al-Fayoum sugar company laboratories.

2.3.1. Impurities of juice, (K and Na) concentrations were estimated as meq/100g beet according to the procedures of sugar company by automated analyzer, as described by Brown and Lilliand (1964). Alpha-amino-N was determined using (Hydrogenation) method according to Carruthers *et al*. (1962).

2.3.2. Sucrose % was polarimetrically determined on a lead acetate extract of fresh macerated root according to the method of Le-Docte (1927).

2.3.3. Purity % = 99.36 - 14.27 (Na + K + Alpha-amino nitrogen) / Sucrose % (Devillers, 1988).

Table (2): Chemical and physical properties of the experimental soil at three locations in Al-Fayoum.

Location	S^1 (Monshat Sinnuris)		S^2 (Monshat bani Othman)		S^3 (Monshat Tantawy)	
Seasons	2017-18	2018-19	2017-18	2019-19	2017-18	2018-19
Mechanical analysis			Partial soil distribution			
Sand %	21.9	23.6	21.2	34.4	24.1	25.5
Silt %	39.9	29.9	35.8	31.9	36.6	37.6
Clay %	38.2	46.5	43.0	33.7	39.3	36.9
Soil texture		Clay Loamy				
Chemical analysis						
EC(dSm^{-1})	3.43	3.71	8.6	8.7	11.94	11.75
Mean of two seasons	3.57		8.6		11.84	
PH(1:2.5)	8.31	8.29	8.16	8.29	8.00	7.80
Sp%	70.0	60.0	39.0	40.0	85.0	83.6
Ca^{++}	9.80	11.3	25.5	26.3	22.47	22.12
Mg^{++}	5.55	5.64	19.5	19.7	27.53	26.88
Na^{+}	18.3	19.7	39.65	40.7	58.35	57.65
K^{+}	0.65	0.42	1.23	1.24	0.46	0.44
HCO_3^{-}	2.50	2.80	6.50	6.90	2.83	2.71
Cl^{-}	26.1	29.2	70.5	70.8	33.33	32.87
SO_4^{-}	5.70	5.10	8.88	8.91	72.65	71.52

Table (3): Chemical composition of the water used for irrigation.

Water used	PH	ECe dSm^{-1}	SAR	Na+	Ca++	Mg++	K+	Cl-	CO3-	HCO3-	SO4-
				Cations and Anions (mmhos/cm)							
	7.75	1.03	1.1	2.2	5.9	4.0	0.2	3.6	0.01	5.5	0.9

2.3.4. Sucrose loss to molasses (SLM %) = 0.14 (Na + K) + 0.25 (Alpha-amino nitrogen) + 0.50 (Devillers, 1988).

2.3.5. Extractable sugar % = Sucrose % – SLM% - 0.6 (Dexter *et al.*, 1967).

2.4. Statistical analysis

Data collected of each season and each location was statistically analyzed according to Gomez and Gomez (1984) by using (MSTAT-C) computer software package. The separate analysis of variance for each experiment (location), and then the combined analysis of variance for different characters were performed on plot mean basis. Revised L.S.D at 5% level was used to compare the means according to Waller and Duncan (1969). Broad-sense heritability (H %) on genotype mean basis was estimated using variance components following the formula according to Johnson *et al.* (1955): $H= \sigma^2g/ (\sigma^2g + \sigma^2e /r + \sigma^2gy /ry)$.

Where, (σ^2g) and (σ^2e) refers to genotypic and error variance, respectively. The divisor (r) refers to the number of replications. Where, σ^2gy refers to genotype by year interaction variance, the divisor y refers to the number of years.

Salinity susceptibility index (SSI) was calculated for each sugar beet variety according to the method of Fischer and Maurer (1978) as follows:

$SSI= (1-\left(\frac{Yd}{Yw}\right))/D$

Where:

(Yd) = mean yield for a variety in stress environment.

(Yw) = mean yield for a variety in normal environment.

D = environmental stress intensity, which was calculated as:

$D= 1-(\frac{\times d}{Xw})$

Xd = mean of all varieties in stress.

Xw = mean of all varieties in normal environment.

Sugar beet varieties with "SSI" value of 1.0 or more than one are susceptible to salinity, while those with values less than 1.0 are less susceptible (tolerant to salinity).

3. RESULTS AND DISCUSSION

3.1. Effect of soil salinity on growth traits

3.1.1. Root length and diameter (cm)

Mean root length, and root diameter as affected by soil salinity levels are given in Table (4). Root length significantly increased but the root diameter decreased by increasing the soil salinity levels. Variety (Cleopatra) recorded the highest root length, 25.0 cm which was significantly higher than the lowest one (Capel), by about 3.2 cm, under severe saline soil (11.84 dSm^{-1}) as compared by the lowest soil salinity (3.57dSm^{-1}), which has the average of root length ranged from 17.5 cm recorded by variety (Tarbelli) to the highest mean root (20.6 cm) recorded by variety (Cleopatra). This finding could be explained by the increasing soil salinity levels, where more water was depleted from the lower depths due to the lack of the available water in the upper layer. So roots tracing behind soil water within the subsoil layer. Ibrahim *et al.* (2002) found that root grows longer under moisture stress.

The interaction between soil salinity and varieties showed significance on root diameter combined over two seasons (Table 4). The highest variety (Toro) had a value of 11.6 cm of root length which was significantly higher than the lowest one (Almas), by about 1.4 cm, under the severe soil salinity level (11.84dSm^{-1}). Also, the same variety (Toro) recorded the biggest root diameter (14.0 and 12.8 cm) under the lowest soil salinity (3.57dSm^{-1}) and the moderate level of soil salinity (8.6 dSm^{-1}), respectively, while the narrow diameter was recorded by varieties (Capel, Carnute, and Almas) under the levels of soil salinity (3.57, 8.60 and 11.84 dSm^{-1}, respectively). Increasing salinity can rapidly inhibit root growth and hence the capacity of water uptake and essential mineral nutrition from soil (Neumann, 1995). The above-mentioned results, also, indicate that the studied parameters of sugar beet growth (root length and root diameter) were influenced by salinity stress.

3.1.2. Root weight and top weight/plant

Root weight and top weight/plant were greatly reduced by high levels of soil salinity (Table 4). The root weight of plants at the highest soil salinity (11.84 dSm^{-1}) decreased by 0.37 kg as compared by the control treatment (3.57 dSm-1). Soil salinity caused positive and significant effects on root weight and the top weight of sugar beet varieties grown in saline soil. The highest values of root weight and top weight (0.62 and 0.25 kg/plant, respectively) were obtained by variety (Toro) under soil salinity (11.84 dSm^{-1}). This superiority may be due to the genetic makeup of this variety, while the lowest values were obtained by varieties Pleno (0.52 kg/plant) and Tarbelli (0.21 kg/plant) under the control treatment (11.84 dSm^{-1}). Salinity stress does not only affect one

Table (4): Means of root length, root diameter and root and top weights of ten sugar beet varieties as affected by soil salinity levels, data are combined across two seasons.

Varieties	Root length (cm)			Mean	Root diameter (cm)			Mean	Root weight (kg)			Mean	Top weight (kg)			Mean
	S 1 3.57 dSm^{-1}	S^2 8.6 dSm^{-1}	S^3 11.84 dSm^{-1}		S 1 3.57 dSm^{-1}	S^2 8.6 dSm^{-1}	S^3 11.84 dSm^{-1}		S 1 3.57 dSm^{-1}	S^2 8.6 dSm^{-1}	S^3 11.84 dSm^{-1}		S 1 3.57 dSm^{-1}	S^2 8.6 dSm^{-1}	S^3 11.84 dSm^{-1}	
Tarbelli	17.5	20.6	22.8	20.3	12.3	11.2	10.7	11.4	0.87	0.85	0.53	0.75	0.31	0.25	0.21	0.26
Pleno	18.2	20.4	22.9	20.5	12.3	10.9	10.2	11.1	0.88	0.84	0.52	0.75	0.33	0.26	0.22	0.27
Farida	18.7	19.2	22.3	20.1	12.3	11.3	10.5	11.4	0.91	0.85	0.54	0.77	0.32	0.25	0.23	0.27
Florima	19.0	21.5	24.2	21.6	13.6	12.7	11.2	12.5	1.01	0.91	0.61	0.84	0.35	0.30	0.23	0.29
Cleopatraa	20.6	22.9	25.0	22.8	13.8	12.1	10.7	12.2	1.04	0.90	0.62	0.85	0.40	0.30	0.25	0.32
Carnute	17.7	20.1	22.7	20.2	12.2	10.5	10.3	11.0	0.93	0.86	0.54	0.78	0.32	0.25	0.22	0.26
Toro	20.6	21.6	24.7	22.3	14.0	12.8	11.6	12.8	1.02	0.95	0.62	0.86	0.33	0.31	0.25	0.30
Capel	18.7	20.6	21.8	20.4	12.0	11.5	10.9	11.5	0.91	0.83	0.53	0.76	0.32	0.24	0.21	0.25
Almas	17.6	19.5	22.2	19.8	12.2	11.3	10.2	11.3	0.90	0.85	0.57	0.77	0.33	0.26	0.22	0.27
Euklid	18.1	20.6	22.8	20.5	12.7	12.2	10.8	11.9	0.86	0.81	0.56	0.74	0.33	0.24	0.21	0.26
Mean	18.7	20.7	23.1	20.8	12.7	11.7	10.7	11.7	0.93	0.87	0.56	0.79	0.33	0.26	0.22	0.27
L.S.D at 0.05																
Salinity (S)				0.339				0.216				0.019				0.010
Varieties (V)				NS				NS				0.035				0.031
SxV				NS				0.310				NS				0.018

* and ** Significant at 0.05 and 0.01 levels of probability, NS= not significant

growth stage, but it could affect the plant differently considering the stress intensity, stress intensity type, plant tolerance, various growth stages, tissue type and plant organs (development). These results are in agreement with those obtained by Munns (2002), who added that highly soluble salts in the root zone cause physiological scarcity in the plant to absorb water, thus, the availability of water may then become so critically low hence growth parameters are inhibited.

3.2. Effect of soil salinity on productivity traits

3.2.1. Top yield (ton/fed) and harvest index %

As shown in Table (5), soil salinity affects clearly sugar beet productivity traits. The results indicate that top yield decreased significantly with increasing soil salinity levels. Top yield (ton/fed) decreased significantly (31.61%) under severe saline soil (11.84 dSm^{-1}) compared to the normal treatment soil (9.08 ton/fed). Under severe saline soil (11.84 dSm^{-1}), the average of top yield for the highest variety (Toro) had value of 6.82 ton/fed which was significantly higher than the lowest one (Capel) by about 1.14 ton/fed, as a compared by the normal soil (3.57dSm^{-1}), the average of top weight ranged from 11.02 ton/fed recorded by variety (Cleopatra) to the lowest mean root (8.39 ton/fed) recorded by variety (Tarbelli). In this regard, Farkhondeh *et al*. (2012) mentioned that, the reduction in top yield as a result of salinity may be attributed mainly to the osmotic inhibition of water absorption, the excessive accumulation of ions such as Na+ or Cl^- in plant cells and inadequate uptake of essential nutrients. In this regard, Eisa *et al*. (2012) stated that salinity is adversely affecting physiological and metabolic processes, finally diminishing growth and yield of the plant.

Harvest index% was significantly decreased with increasing soil salinity. Table (5) represents the obtained results for the effects of soil salinity on the harvest index % of sugar beet, which were indicated by the root yield and top yield. The results indicate significant differences among the harvest index measurements as a result of variation in soil salinity. Under severe saline soil (11.97 dSm^{-1}), the average of harvest index % for the highest variety (Florima) had a value of 68% which was significantly higher than the lowest one (Euklid)), by about 3%.
Miransari and Smith, (2007) found that soil salinity decreases crop yield through increasing osmotic stress on the plant.

3.2.2. Root and sugar yields (ton/fed)

Data in Table (5) show that, root yield and sugar yield were significantly decreased by increasing soil salinity levels as compared with the control treatment (3.57 dSm^{-1}). The magnitude of reduction differs from one trait to another. The lowest values of sugar and root yields were registered under severe soil salinity (11.84 dSm^{-1}) as compared to the control treatment. Munns and Tester (2008) suggested that the depressive effects of NaCl on the yield of plants may be due to the inhibitory effect of salinity on plant growth and yield has been ascribed to osmotic effect on water availability, ion toxicity, nutritional imbalance, and reduction in enzymatic and photosynthetic efficiency and other physiological disorders.

The interaction between salinity levels and sugar beet varieties significantly affected root yield and sugar yield. Regardless of plant variety, the increasing salinity level of soil reduced all growth criteria for all varieties with different magnitude. However, variety (Florima) recorded the highest root and sugar yields (13.71 and 1.82 ton/fed), under severe saline soil (11.84 dSm^{-1}), which was significantly higher than the lowest one (Euklid), by about 2.4 and 0.43ton/fed, as a compared by the normal soil (3.57dSm^{-1}). The reasons for decreasing sugar and root yields under considerable salinity levels may be due to osmotic stress which reduces leaf area and decreasing chlorophyll contents which in turn reduce sugar beet yield. Yield parameters of sugar beet were reduced with an increasing salt concentration of soil as reported by Mekki and El-Gazzar (1999). Such reduction might be due to the lowering of the external water potential or the effect of ion toxicity on metabolic processes (De-Herralde *et al*., 1998).

3.3. Effect of soil salinity on quality traits

3.3.1. Sucrose and extractable sugar %

The results in Table (6) indicated that increasing soil salinity affected significantly sucrose% and extractable sugar%, which were decreased with increasing soil salinity levels. Sucrose % and extractable sugar % decreased significantly (15.35 % and 12.67%, respectively) under severe soil salinity (11.84 dSm^{-1}) compared to the normal treatment soil (16.83% and 14.12%, respectively). Under severe saline soil (11.84 dSm^{-1}), the average of sucrose % and

Table (5): Means of top yield, root yield, sugar yield and harvest index of ten sugar beet varieties as affected by soil salinity Levels, data are combined across two seasons.

Varieties	Top yield (ton/fed)			Mean	Root yield (ton/fed)			Mean	Sugar yield (ton/fed)			Mean	Harvest index %			Mean
	S 1 3.57 dSm^{-1}	S2 8.6 dSm^{-1}	S3 11.84 dSm^{-1}		S 1 3.57 dSm^{-1}	S2 8.6 dSm^{-1}	S3 11.84 dSm^{-1}		S 1 3.57 dSm^{-1}	S2 8.6 dSm^{-1}	S3 11.84 dSm^{-1}		S 1 3.57 dSm^{-1}	S2 8.6 dSm^{-1}	S3 11.84 dSm^{-1}	
Tarbelli	8.39	6.77	6.05	7.07	20.13	19.04	12.30	17.16	2.80	2.50	1.56	2.28	71	74	67	70
Pleno	8.89	7.17	5.89	7.31	20.42	19.71	11.71	17.28	2.86	2.49	1.45	2.27	70	73	67	69
Farida	8.75	6.75	6.25	7.25	20.42	19.75	11.46	17.21	2.88	2.58	1.41	2.29	70	75	65	69
Florima	9.48	8.07	6.37	7.97	22.13	20.58	13.71	18.81	3.31	2.85	1.82	2.66	70	72	68	70
Cleopatraa	11.02	8.18	6.73	8.64	22.13	20.21	13.08	18.47	3.24	2.78	1.77	2.60	67	71	66	68
Carnute	8.80	6.72	6.00	7.17	21.21	20.08	11.83	17.71	3.04	2.58	1.46	2.36	71	75	66	71
Toro	8.98	8.55	6.82	8.11	22.13	20.58	13.33	18.68	3.26	2.85	1.80	2.64	71	71	66	69
Capel	8.59	6.43	5.68	6.90	20.50	19.83	12.13	17.49	2.74	2.52	1.51	2.25	70	76	68	71
Almas	8.98	7.04	6.05	7.35	20.38	19.92	11.71	17.34	2.81	2.50	1.40	2.24	69	74	66	70
Euklid	8.93	6.46	6.23	7.21	20.25	19.67	11.38	17.10	2.72	2.48	1.39	2.20	69	75	65	69
Mean	9.08	7.21	6.21	7.5	20.97	19.94	12.26	17.72	2.96	2.61	1.55	2.37	70	73	66	70
L.S.D at 0.05																
Salinity (S)				0.490				0.282				0.100				NS
Varieties (V)				0.269				0.315				0.055				0.043
SxV				0.380				0.542				0.078				NS

* and ** Significant at 0.05 and 0.01 levels of probability, NS= not significant

Table (6): Means of SLM (%), extractable sugar (%), purity (%) and sucrose (%) of ten sugar beet varieties as affected by soil salinity levels, data are combined across two seasons

Varieties	SLM (%)			Mean	Extractable sugar (%)			Mean	Purity (%)			Mean	Sucrose (%)			Mean
	S 1 3.57 dSm^{-1}	S2 8.6 dSm^{-1}	S3 11.84 dSm^{-1}		S 1 3.57 dSm^{-1}	S2 8.6 dSm^{-1}	S3 11.84 dSm^{-1}		S 1 3.57 dSm^{-1}	S2 8.6 dSm^{-1}	S3 11.84 dSm^{-1}		S 1 3.57 dSm^{-1}	S2 8.6 dSm^{-1}	S3 11.84 dSm^{-1}	
Tarbelli	2.13	2.02	2.08	2.08	13.89	13.13	12.68	13.23	79.80	74.31	68.51	74.21	16.57	15.75	15.41	15.91
Pleno	2.07	2.08	2.13	2.09	13.99	12.65	12.42	13.02	79.53	63.52	57.56	66.87	16.72	15.33	15.09	15.71
Farida	2.13	2.08	2.08	2.10	14.09	13.05	12.30	13.15	79.01	74.34	67.96	73.77	16.77	15.73	15.03	15.84
Florima	2.03	1.95	2.06	2.01	14.94	13.85	13.30	14.03	81.46	76.00	70.39	75.95	17.6	16.4	15.93	16.64
Cleopatraa	2.02	2.02	2.06	2.03	14.63	13.77	13.52	13.97	81.68	65.67	59.78	69.04	17.29	16.39	16.14	16.61
Carnute	2.11	2.10	2.15	2.12	14.32	12.85	12.36	13.18	79.77	73.82	68.00	73.86	17.07	15.55	15.07	15.90
Toro	2.01	2.01	2.07	2.03	14.74	13.83	13.51	14.03	81.59	75.70	70.26	75.85	17.41	16.44	16.12	16.66
Capel	2.05	2.08	2.13	2.09	13.35	12.69	12.44	12.83	79.57	73.61	66.62	73.27	16.08	15.37	15.09	15.51
Almas	2.09	2.09	2.19	2.12	13.80	12.56	11.96	12.77	78.24	63.36	57.85	66.48	16.59	15.25	14.65	15.50
Euklid	2.11	2.21	2.18	2.17	13.43	12.61	12.22	12.75	79.02	72.59	66.75	72.79	16.21	15.42	14.93	15.52
Mean	2.08	2.06	2.12	2.09	14.12	13.10	12.67	13.29	79.97	71.29	65.37	72.21	16.83	15.76	15.35	15.98
L.S.D at 0.05																
Salinity (S)				0.091				0.354				0.709				0.196
Varieties (V)				0.050				0.194				0.389				0.358
SxV				0.070				0.274				0.549				NS

* and ** Significant at 0.05 and 0.01 levels of probability, NS= not significant

extractable sugar % for the highest variety (Cleopatra) had value of (16.14 and 13.52 %) which was significantly higher than the lowest one (Almas), by about (1.49 and 1.56%), as compared by the normal soil (3.57dSm^{-1}). The reduction in sucrose and extractable sugar % may be due to salt stress and ion imbalance stress as well as the toxic effect of Na^- or Cl^- ions and the osmotic potential of the soil solution (Gobarh, 2001).

3.3.2. Purity % and sucrose loss to molasses (SLM) %

Data in Table (6) indicated that the purity % was decreased significantly by about (18.25%) under severe saline soil (11.84 dSm^{-1}) compared to the normal treatment soil (79.97%), but sucrose loss to molasses (SLM %) was increased non-significantly by about (1.92%) under severe soil salinity compared to the normal soil (2.08%). Under severe saline soil (11.84 dSm^{-1}), the average of sucrose % and extractable sugar % for the highest variety (Florima and Almas) had values of (70.39 and 2.19%, respectively) which was significantly higher than the lowest ones (Pleno and Cleopatra), by about (12.83 and 0.13 %, respectively), as compared by the normal soil (3.57dSm^{-1}). The significance of soil salinity levels × varieties interaction ($P \leq 0.05$) showed that the studied cultivars did not have the uniform performance at different soil locations. Khalil *et al*. (2001) found that sucrose, total soluble solids and purity of sugar beet juice increased with increasing K level, but decreased with salinity stress.

3.3.3. Effect of soil salinity on sugar beet impurities

Data in Table (7) show that there were significant differences in the values of potassium (K), and sodium (Na) as well as α- amino nitrogen (N) between the different soil salinity levels. The mean values for K, Na and N increased with increasing the level of soil salinity. Under severe soil salinity (11.84 dSm^{-1}), the highest values of K and α Amino nitrogen (5.30 and 2.05% , respectively) were recorded by variety (Almas), while the highest values of Na (3.48 %) was registered by variety (Capel). There is non-significant variance for soil salinity levels × varieties interactions ($P \leq 0.05$) for all impurities, except Na%. The accumulation of Na in leaves parallel with decreasing K content, may give an important explanation for the reflection of salt stress on yield (Eisa *at al*., 2011). Selective K+ uptake has been reported to be associated with salt tolerance in sugar beet (Deinlein *et al*., 2014).

Table (7): Means of potassium (K %), sodium (Na %) and alpha-amino (N %) of ten sugar beet varieties as affected by soil salinity levels, data are combined across two seasons.

Varieties	Potassium (K %)			Mean	Sodium (Na %)			Mean	Alpha-amino (N			Mean
	S 1 3.57 dSm^{-1}	S2 8.6 dSm^{-1}	S3 11.84 dSm^{-1}		S 1 3.57 dSm^{-1}	S2 8.6 dSm^{-1}	S3 11.84 dSm^{-1}		S 1 3.57 dSm^{-1}	S2 8.6 dSm^{-1}	S3 11.84 dSm^{-1}	
Tarbelli	5.06	5.15	5.17	5.13	3.10	2.99	2.91	3.00	1.97	1.53	1.81	1.77
Pleno	5.25	5.11	5.12	5.16	2.97	3.04	3.32	3.11	1.67	1.76	1.81	1.74
Farida	5.26	5.18	5.25	5.23	3.10	2.90	3.08	3.03	1.85	1.80	1.64	1.76
Florima	4.80	4.86	4.85	4.84	2.92	2.91	2.96	2.93	1.79	1.45	1.87	1.70
Cleopatra	4.97	4.73	4.79	4.83	3.07	3.08	2.98	3.04	1.59	1.71	1.88	1.73
Carnute	5.17	5.17	5.16	5.17	2.99	2.98	3.35	3.11	1.87	1.83	1.83	1.84
Toro	4.70	4.87	4.77	4.78	3.03	3.01	3.07	3.04	1.72	1.62	1.88	1.74
Capel	4.95	5.01	5.11	5.02	2.94	3.19	3.48	3.20	1.79	1.72	1.70	1.74
Almas	5.19	5.03	5.30	5.17	3.25	3.21	3.08	3.18	1.65	1.75	2.05	1.82
Euklid	5.24	5.09	5.15	5.16	3.21	3.49	3.41	3.37	1.72	2.05	1.93	1.90
Mean	5.06	5.02	5.07	5.05	3.06	3.08	3.18	3.11	1.76	1.72	1.84	1.77
L.S.D at 0.05												
Salinity (S)				0.163				0.160				NS
Varieties (V)				NS				0.088				0.094
SxV				NS				0.124				NS

* and ** Significant at 0.05 and 0.01 levels of probability, NS= not significant

3.4. Broad-sense heritability%

The genotypic coefficient of variations is not a correct measure to know the heritable variation present and should be considered together with heritability estimates. In the current study, high heritability (broad sense) estimates (Fig.1) at combined of two years were recorded for purity% (95.42%), extractable sugar % (94.9%), root length (93.36%), sucrose %(92.94%), harvest index% (92.55%) and root weight (92.05 %), respectively. However, the lowest heritability was recorded by root diameter (35.71%), top weight (37.04 %), SLM% (21.81%), and N % (21.84%), respectively. Abu-Ellail *et al*., (2017) reported that estimates of heritability are more important for selection; where the significant genotypic effects indicated the existence of genetic variability among the genotypes and the possibility of utilizing them in genetic improvement. Falconer and Mackey (1996) suggested that estimates of heritability are subject to environmental conditions, and therefore may be used with great care and caution in the plant improvement programs. Broad sense- heritability degrees are useful parameters that can help the breeder during different stages of crop improvement. The success of the breeding programs will depend largely on the extent of heritability for important economic traits in sugar beet varieties.

and sugar yields <1 and were relatively tolerant to salinity stress. SSI of root and sugar yields (ton/fed) indicated that the varieties Florima, Tarbelli, Toro, Cleopatra, and Capel were tolerant to soil salinity, which had SSI values less than one. In addition, severe soil salinity stress reduced root and sugar yields by reducing the root weight/plant, root diameter, sucrose% and extractable sugar % compare results with performance under normal soil conditions. Yield components are the most important agronomic traits in selecting for varieties tolerant to soil salinity stress. The sugar yield was most affected than the root yield, and the decrease percentage of root and sugar yields ranged from 38.05 and 44.29 % for varieties (Florima and Tarbell, respectively) to the highest values 44.22 and 51.97% for variety (Carnute). The most sensitive varieties were Almas, Euklid, Pleno, Farida, Carnute had salinity susceptibility index (SSI) more than unity. Root and sugar yields confirmed that it is important to use these traits as useful selection criteria for screening the soil salinity tolerance in terms, most importantly, both traits can be considered for screening sugar beet varieties at high soil salinity. Krishnamurthy *et al* ., (2016) and Abu El-lail *et al*., (2014) found that the least SSI values indicate the genotypes with the highest rate of tolerance under salinity (the least yield

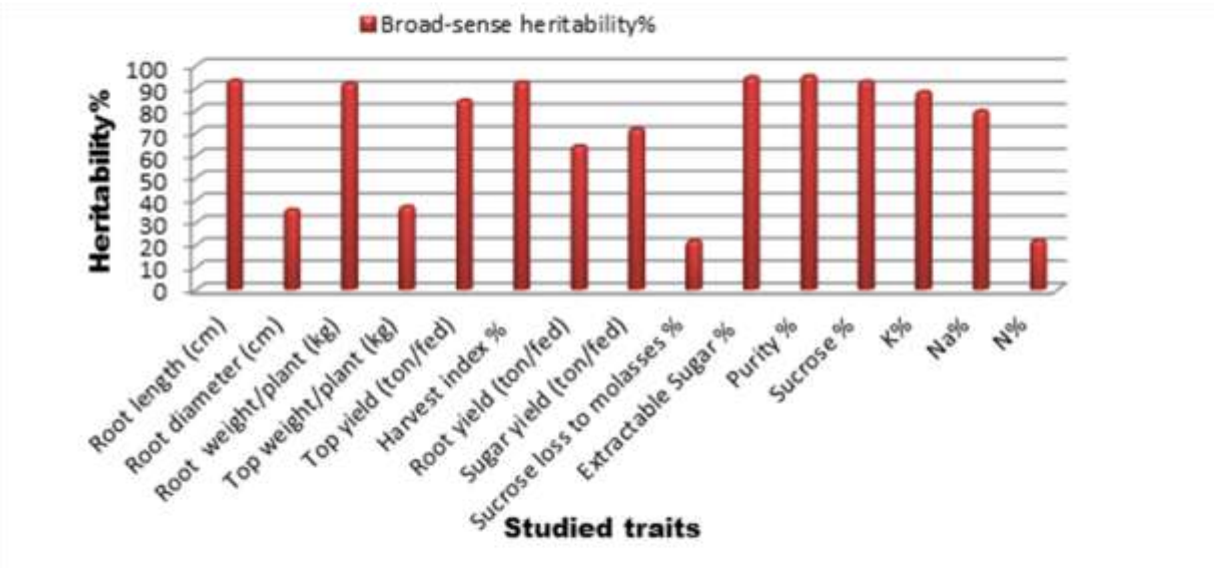

Fig.(1): broad-sense heritability of studied traits under soil salinity treatments.

3.5. Salinity susceptibility of sugar beet varieties

The results showed that five varieties had a salinity susceptibility index (SSI) based on root

difference under normal and stress conditions), under stress the yield decreases and selection of more tolerant genotypes may be a suitable method.

Table (8): Decrease percentage and salinity susceptibility index (SSI) of root and sugar yields (ton/fed) of ten sugar beet as affected by soil salinity levels combined over two seasons.

Varieties	Root yield (ton/fed)			Sugar yield (ton/fed)		
	SSI	Decrease percentage		SSI	Decrease percentage	
		S^1-S^2/S^1%	S^1-S^3/S^1%		S^1-S^2/S^1%	S^1-S^3/S^1%
Tarbelli	0.94	5.41	38.90	0.93	10.71	44.29
Pleno	1.03	3.48	42.65	1.03	12.94	49.30
Farida	1.06	3.28	43.88	1.07	10.42	51.04
Florima	0.92	7.00	38.05	0.94	13.90	45.02
Cleopatra	0.98	8.68	40.89	0.95	14.20	45.37
Carnute	1.06	5.33	44.22	1.09	15.13	51.97
Toro	0.96	7.00	39.77	0.94	12.58	44.79
Capel	0.98	3.27	40.83	0.94	8.03	44.89
Almas	1.02	2.26	42.54	1.05	11.03	50.18
Euklid	1.05	2.86	43.80	1.03	8.82	48.90
Mean	**1.00±0.03**	**4.91±0.76**	**41.54±0.74**	**1.00±0.05**	**11.82±0.66**	**47.64±0.59**

Conclusion

Based on the obtained results, soil salinity stress significantly influenced the root yield and sugar yield. The studied varieties, as well, showed different reactions to salinity stress. There are acceptable varieties to be introduced to the farmers for cultivation under salinity conditions. But, further research in this regard can provide more comprehensive results. The varieties Florima, Toro Cleopatra, Tarbell, had SSI less than unity and performed the best in relation to root yield and sugar yield. Hence, these varieties can be cultivated as commercial varieties in districts of high soil salinity. Generally, the screening of the varieties under real and high salt stress conditions provides the researcher the ability to attain valuable results regarding the selection of salt-tolerant genotypes. The supplementary experiments can be utilized to take more effective steps towards introducing more salt-tolerant varieties. The success of the breeding programs will depend largely on the extent of heritability for important economic traits in sugar beet varieties. Evaluating sugar beet crop response under stress is a useful and promising tool for the development of tolerant crop varieties.

4. REFERENCES

Abdel-Latef A.A. (2005). Salt tolerance of some wheat cultivars. Ph. D. Thesis, Fac. of Science, South Valley Univ., Qena, Egypt.

Abu-Ellail F.F.B., El-Taib A. B. A. and Masri M. I. (2017). Broad-sense heritability, genetic correlation and genetic variability of sugarcane yield components at first selection stage. J. Sugarcane Res. 7 (1): 27 – 34.

Abu El-lail F.F.B., Hamam K.A., Kheiralla K.A. and El-Hifny M. Z. (2014). Salinity tolerance in 280 genotypes of two-rows barley. Egypt. J. Plant Breed., 18: 331-345.

Annual Report of Sugar Crops Council (2019). In Aabic: 1-50

Allard R.W. (1960). Principles of Plant Breeding. John Willey and sons, Inc. New York., USA.

Black C. A., Evans D. D., Ensminger L. E., white J. L. and Clark F. E. (eds.).(1965). Methods of Soil Analysis. Amer. Soc. Agron. Madison, WI, USA.

Bray E.A., Bailey-Serres J. and Weretilny K.E. (2000). Responses to abiotic stresses. In; Gruissem, W., Bucha Man, B. and Jones, R. (eds), Biochemistry and Molecular Biology of Plants. Amer. Soc. Plant Phys., Rockville, MD, USA, pp 1158-1249.

Brown J.D. and Lilliand O. (1964). Rapid determination of potassium and sodium in plant material and soil extracts by Flamphotometry. Proc. Amer. Soc. Hort. Sci., 48: 341-346.

Carruthers A., Oldfield J.F.T. and Teague H.J. (1962). Assessment of beet quality. The 15th Annual Technical Conference, British Sugar Corporation LTD. 36pp.

Devillers P. (1988). Prevsion du sucre melasse. Scurries Francases, 129, 190-200. (C.F. The Sugar Beet Book).

Dexter S.T., Frankes M.G. and Snyder F.W. (1967). A rapid and practical method of determining extractable while sugar as may be applied to the evaluation of agronomic practices and grower deliveries in the sugar beet industry. J. Am. Soc. Sugar beet Technol., 14, 433 – 454.

De-Herralde F., Biel C., Save R., Morales M.A., Torrecillas A. and Alarcon J.J. (1998). Effect of water and salt stresses on the growth, gas exchange and water relations in *Argyranthemum coronopiflium* plants. Crop Sci., 139: 9-17.

Deinlein U., Stephan A.B., Horie T., Luo W., Xu G. and Schroeder J.I. (2014). Plant salt-tolerance mechanisms. Trends in Plant Sci., 19 (6): 371-379.

Eisa S.S., Ibrahim A.M., Khafaga H.S. and Shehata S.A, (2012). Alleviation of adverse effects of salt stress on sugar beet by pre-sowing seed treatments. J. Appl. Sci. Res., 8 (2): 799-806.

Eisa S.S., Hussin S. and Abd El-Samad E.H. (2011). Enhancement of sugar beet productivity under saline conditions. J. Appl. Sci. Res., 7 (12): 2063-2072.

El- Hendawy S.E., Hu Y., Yakant G.M., Awad A.M., Hafiz S.E. and Schmidhalter U. (2004). Evaluating salt tolerance of wheat genotypes using multiple parameters. Eur. J. Agron., 22:245-253.

Farkhondeh R., Nabizadeh E. and Jalilnezhad N. (2012). Effect of salinity stress on proline content, membrane stability and water relation in two sugar beet cultivars. Int'l J. Agric. Sci., 2: 385-392.

Falconer D. S. and Mackey T.F.C. (1996). Introduction to Quantitative Genetics. 3[rd] Ed. Longman, London,UK.

Fischer R.A. and Maurer R.O. (1978). Drought resistance in spring wheat cultivars 1- Grain yield responses. Aust. J. Agric. Res., 29:897-912.

Gobarh M. E., (2001). Effect of foliar application with some micronutrients on sugar beet grown in newly reclaimed sandy soil. J. Agric. Sci., Mansoura Univ., 26 (10): 5929-5937.

Gomez K.A. and Gomez A.A. (1984). Statistical Procedures for Agriculture Research . John Wiley and Sons. Inc. New York,USA.

Ibrahim M.M., Khalifa M.R., Korim M.A., Zein F.I. and Omer E.H. (2002). Yield and quality of sugar beet crop as affected by mid to late season drought and potassium fertilization at north Nile Delta. Egypt. J. Soil Sci., 42(1): 87 - 102.

Jackson M.L. (1973). Soil Chemical Analysis. Prentice Hall. Englewood Cliffs, New Jersey,USA.

Johnson W.H., Robinson H.E. and Comstok R.E. (1955).Estimation of genetic and environmental variability in soybean. Agron. J., 47:314-318.

Khalil S.M., Mostafa S.N. and Mostafa Z.R. (2001). Influence of potassium fertilizer and soil salinity on chemical composition of sugar beet root. Minufiya J. Agric. Res., 26 (3): 583–594.

Krishnamurthy S.L., Sharma P.C., Sharma S.K., Batra V., Kumar V. and Rao L.V.S. (2016). Effect of salinity and use of stress indices of morphological and physiological traits at the seedling stage in rice. Indian J. Exp. Biol., (54):843-850.

Le-Docte A. (1927). Commercial determination of sugar beet root using the Sachr Le-Docta process. Int'l. Sugar J., 29: 488-492. (C.F. Sugar beet nutrition, Applied Sciences Publishers LTD, London, A.P. Draycott).

Mekki B.B. and EL-Gazzar M.M. (1999). Response of root yield and quality of sugar beet (*Beta vulgaris* L.) to irrigation with saline water and foliar potassium Fertilization. Ann. Agr. Sci., 44 (1): 213-225.

Miransari M and Smith D.L. (2007). Overcoming the stressful effects of salinity and acidity on soybean [*Glycine max* (L.) Merr.] nodulation and yields using signal molecule genistein under field conditions. J. Plant Nutri., 30: 1967-92.

Munns R. and Tester M. (2008). Mechanisms of salinity tolerance. Ann. Rev. Plant Biol., 59: 651-681.

Munns R. (2002). Comparative physiology of salt and water stress. Plant, Cell & Environ., 25 (2): 239-250.

Neumann P.M. (1995). Inhabitation of root growth by salinity stress: Toxicity of an adaptive biophysical response. In :Baluska f. Ciamporova M., Structure and function of roots, Kluwer Academic Publishers. The Netherlands, pp. 299-394 .

Pathak H. and Rao D.L.N. (1998). Carbon and nitrogen mineralization from added organic matter in saline and alkaline soils. Soil Biol. Biochem.., 30(6): 695-702.

Qadir M., Ghafoor A. and Murtaza G. (2000).

Amelioration strategies for saline soils: a review, Land Degrad. Dev.,11(6):501-521.

Steduto P., Hsiao T. C., Fereres E. and Raes D. (2012). Crop yield response to water. FAO, Irrigation and Drainage Paper, No. 66, Rome, Italy, 207.

Waller R.A. and Duncan D.B. (1969). A bays rule for the symmetric multiple comparison problem. Amer. State. Assoc. J. Des., 1458-1503.

Yusuf M., Hasan S.A., Ali B., Hayat S., Fariduddin Q. and Ahmed A. (2007). Effect of salicylic acid on salinity induced changes in *Brassica juncea*. J. Integrative Plant Biol., 50: 1096-1102.

درجة التوريث وأداء عشرة أصناف من بنجر السكر للنمو والمحصول وجودة العصير تحت مستويات مختلفة من ملوحة التربة

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ملخص

تؤثر ملوحة التربة على الإنتاج النباتي، بما في ذلك بنجر السكر خاصة في محافظة الفيوم. تعتبر غربلة الأصناف المتحملة للملوحة أحد الطرق المستخدمة بواسطة مربى النبات في بنجرالسكر. تم إجراء البحث في محافظة الفيوم (29 ° 17` شمالاً ؛ 30 ° 53` شرقًا) ، مصر ، خلال موسمي 2017 2018 و 2019/2018. كان الهدف هو دراسة تأثير ملوحة التربة في ثلاثة قرى، S^1 (منشأت سنورس) ومستوى الملوحة بها. ($3.57\ dSm^{-1}$)، وS^2 (منشأت بني عثمان) ومستوى الملوحة بها. ($8.6\ dSm^{-1}$)، و S^3 (منشأت طنطاوى) ومستوى الملوحة بها ($11.84\ dSm^{-1}$) ، على نمو النبات ، صفات الجودة والعائد لعشرة أصناف من بنجر السكر متعددة الأجنة. كان التصميم التجريبي هو قطاعات كاملة العشوائية مع ثلاث مكررات. أظهرت النتائج أن إنتاجية محصولى الجذور والسكر قد انخفضا بشكل ملحوظ بزيادة مستويات ملوحة التربة مقارنة بمستوى ملوحة التربة الطبيعية. كان صنف (Florima) متفوقًا في محصول الجذر والسكر (13.71 و 1.82 طن / للفدان على التوالى) ؛ من ناحية أخرى، سجل الصنف (Euklid) أدنى قيم لمحصولى الجذور والسكر (11.38 و 1.39 طن / للفدان). أما بالنسبة للتفاعل بين مستويات ملوحة التربة وأصناف بنجر السكر، فقد سجلت أعلى القيم لإنتاجية الجذر والسكر الأصناف فلوريما، تورو، كليوباترا، تاربيلي، على التوالي في تربة متأثرة بالملوحة الشديدة ($11.84\ dSm^{-1}$). ويوصى بزراعة تلك الأصناف سابقة الذكر في الأراضى المتأثرة بالملوحة حيث تتحمل ملوحة التربة ويتوقع أن تنتج محصول جذور ثابت وعائد جيد من السكر. أشارت النتائج الى أن درجة التوريث من الصفات التى لها أهمية كبيرة بالنسبة للمربين لأن قيمتها تشير إلى الدقة التي يمكن بها التعرف على الصنف من خلال تعبيره المظهري وتحديد الجيل الذي يمكن أن يكون فيه الاختيار مربحاً. أظهرت النتائج أن خمسة أصناف لديها مؤشر حساسية للملوحة (SSI) على أساس العائد من محصولى الجذور والسكر <1 وكانت متحملة نسبيا تأثير الملوحة.

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