RESPONSE OF SOME SUGAR BEET VARIETIES TO THE INTEGRATED SOIL AND FOLIAR APPLICATION OF POTASSIUM IN SALINE SOIL

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ABSTRACT

Two field experiments were carried out at Gelbana district, Sahl El-Tina (longitudes 32º 20' and 32º 33' E and latitudes 30º 57' and 31º 04' N), North Sinai Governorate during the two seasons of 2011/2012 and 2012/2013 to study the effect of the combined application of potassium fertilizer on some chemical compositions, growth, yield and quality of sugar beet under saline soil. This work included eighteen treatments represent the combinations among three multi-germ sugar beet varieties *viz.* Gloria, Toro and Desperez poly N and six K-combinations, which were:

1) The check treatment (without K application).
2) 3 cm^3 l^{-1} as potassium silicate as foliar application,
3) 24 kg K_2O fed^{-1} as potassium sulphate as soil application.
4) 48 kg K_2O fed^{-1} as potassium sulphate as soil application.
5) 24 kg K_2O fed^{-1} as potassium sulphate + 3 cm^3 l^{-1} potassium silicate.
6) 48 kg K_2O fed^{-1} as potassium sulphate + 3 cm^3 l^{-1} potassium silicate.

A split plot design was used with three replications in both seasons, the main plots were assigned to K-fertilization treatments, while sugar beet varieties were sown randomly in the sub plots. The obtained results pointed out the following.

The applied potassium treatments either soil or foliar application alleviated the adverse effect of soil salinity and significantly increased chlorophyll a, b and carotenoides, root length, diameter and fresh weight/plant, sucrose%, sugar extracted%, quality index as well as root and recoverable sugar yields/fed and reduced Na root content, while increased K/Na ratio in root in comparison to the control, in both seasons.

The application of K-fertilizer at 24 and/or 48 kg K_2O fed^{-1} as soil side dressing of K-sulphate, along with the foliar application of K-silicate at 3 cm^3 l^{-1} were more effective and significantly increased root yield (ton fed^{-1}) by (8.19 and 10.24 %), and sugar yield by (8.83 and 13.85%) compared to the soil single application in the 1st season and the 2nd one was the same trend. Supplying sugar beets by 48 kg K_2O fed^{-1} as form of K-sulphate, given as soil application, combined with foliar application of 3 cm^3 l^{-1}, as K-silicate, significantly increased quality index and sucrose% and reduced impurity index in both seasons compared to the soil single application.

Gloria variety showed the superiority over the other tested ones and recorded the highest values of chlorophyll a, b, proline, the thickest and heaviest roots/plant, root and recoverable sugar yields/fed., sucrose%, sugar extraction% in both seasons and K/Na ratio in the 2nd one. Fertilizing Gloria sugar beet variety with 48 kg K_2O fed^{-1} as K-sulphate added to the soil integrated with 3 cm^3 l^{-1} of K-silicate sprayed on beet foliage can be recommended to get the highest root yield/fed and sucrose% and the lowest content of sodium in juice in Sahl El-Tina, North Sinai.

Keywords: *Potassium silicate, potassium sulphatee, quality, salinity, sugar beet, varieties and yield*.

INTRODUCTION

Sugar beet (*Beta vulgaris,* var. saccharifera) is one of the main sources for sugar production in Egypt. It is adapted to a wide range of climatic and soil conditions and is not overly sensitive to salinity **(Ahmed, *et al.*, 2012)**. However, salinity is the major limiting factor and most serious environmental problem for sugar beet growth in most of newly reclaimed soils, especially at germination and the early stage of growth. In this context, **Ali, *et al*. (2001)** showed that salinity affects the physiological activities such as photosynthesis and respiration. Moreover, water balance, turgor pressure, degeneration of cell membranes**,** efficiency of enzymes, synthesis and storage of assimilates and metabolites such as proline are directly affected by salt stress **(Jamil, *et al*. 2007)**.

The beneficial role of supplying plants grown under salinity condition with potassium have been shown by some researchers, who showed that potassium mitigates the adverse effects of salinity on plant growth by regulating desirable K/Na ratio, increases salt tolerance as determined by the mechanism of salt exclusion associated with selectivity of K uptake by roots and preferential loading of K rather than Na in xylem **(Munns, 2002)**. Also, potassium plays a significant role in the opening and closing of leaf stomata's which control the movement of CO_2 into the plant and water out into the air, and would therefore have an effect on stomata conductance **(Bednarz, *et al.*, 1998)**. Increasing the application of potassium enhances photosynthetic rate, plant growth and yield in different crops under salinity stress conditions, Addition of K to saline soils avoids Na toxicity by maintaining a high level of K in the terms of high level of K uptake against Na **(Zayed, 2003)**. It improves the quality of sugar beet grown under saline condition (**Abdel-Mawly and Zanouny, 2004)**. Moreover, **Draycott (2006)** pointed out that K plays essential roles in enzyme activation, protein synthesis, osmoregulation, energy transfer, cation-anion balance and stress resistance. He added that potassium increases salt tolerance of sugar beet by enhancing the biosynthesis of organic metabolites and improving nutritional status. In addition, **Mehran and Samad (2013)** showed that increasing K rates significantly increased root and foliage fresh weight and sugar yield of sugar beet plants. **Hussain *et al.*, (2014)** explained that K_2SO_4 increased yields of sugar beet by mitigating the adverse effect of Na and thus would be an effective source of K for crop production in saline soils.

Application of K-sulphate may be also beneficial for sugar beet grown in saline soils, where K-sulphate contains sulphur, which is one of the major nutrients required for synthesis of amino acids, needed to produce functional and structural proteins. In Egyptian soils, which are characterized with its high pH, Sulphur also can improve growth and alleviate the adverse effects of salinity through reducing soil pH and increasing the activity of soil microorganism by the oxidation of S to sulphate through various species of soil microorganisms **(Kassem, 2012)**. The exogenous application of potassium silicate (K_2SiO_3) reduced sodium uptake, increased potassium and consequently improved, plant weight, and photosynthesis rate of wheat under salt stress **(Ahmad, 2013)**. In addition, **Soudi (2013)** reported that foliar spray with 2000 ppm K-silicate attained the highest values of root and whole plant fresh weight and chlorophyll a and b of sugar beet plant. Potassium silicate contains silicon, which is not considered as an essential element for plant growth, however, a number of studies have shown that silicon may increase salinity tolerance in wide variety of plants through different mechanisms including, increased enzyme activity, and concentration of soluble substances in the xylem, resulting in limited sodium adsorption by plants and translocation in addition, it protects plants against excessive loss of water by transpiration through a reduction in the diameter of stomatal pores **(Liang, 1999)**.

Regarding the variation among sugar beet varieties under saline conditions, some researchers mentioned that different cultivars of the same plant have different performances, **Hozayn, *et al*. (2013)** recorded significant differences among the tested cultivars in all studied characters of sugar beet grown under newly reclaimed soil. **Zaki, *et al.* (2014)** revealed that all the evaluated sugar beet varieties exhibited significant differences in all yield criteria under saline stress.

The aim of this work was to study the response of three sugar beet varieties to the integration of soil and foliar application of potassium under saline soil condition.

MATERIALS AND METHODS

Two field experiments were carried out at Gelbana district, Sahl El-Tina (longitudes 32º 20' and 32º 33' E and latitudes 30º 57' and 31º 04' N), North Sinai Governorate during the two seasons of 2011/2012 and 2012/2013 to study the effect of the combined application of potassium fertilizer on some chemical compositions, growth, yield and quality of sugar beet under saline soil. This work included eighteen treatments represent the combinations among three multi-germ sugar beet varieties *viz.* Gloria, Toro and Desperez poly N and six K-combinations, which were:

1) The check treatment (without K application).
2) 3 cm^3 l^{-1} (180 g K_2O /fed) as potassium silicate as foliar application.
3) 24 kg K_2O fed^{-1} as potassium sulphate as soil application.
4) 48 kg K_2O fed^{-1} as potassium sulphate as soil application.
5) 24 kg K_2O fed^{-1} as potassium sulphate + 3 cm^3 l^{-1} as potassium silicate.
6) 48 kg K_2O fed^{-1} as potassium sulphate + 3 cm^3 l^{-1} as potassium silicate.

The experiments were conducted in a split plot design, where the main plots were assigned to K-fertilization treatments, while the three sugar beet varieties were sown randomly in the sub plots, which area was 16.8 m^2, comprised of 4 rows of 7-m long and 60-cm apart. Sowing date was on October 1^{st} in two growing seasons. Soil application of potassium sulphate was given in two equal doses; the first was during soil preparation and the other was given with second dose of N- fertilizer. Nitrogen fertilizer was applied at rate of 120 kg N/fed as urea (46% N) in three equal doses, the first after thinning (4-6 true leaves at 40 days from sowing) and two doses given at two-week intervals after the first one. Overall dose of 200 kg/fed of Calcium super phosphate (15% P_2O_5) was applied during seed bed preparation. The foliar application of potassium silicate was done after 60 and 75 days from sowing. Other agricultural practices were done as recommended by Sugar Crops Research Institute.
Soil samples (0-30 cm depth) were collected from the experimental site to determine its physical and chemical properties using the methods described by **Cottenie, *et al.* (1982)**. The obtained data are presented in Table (1).

Table (1): Some physical and chemical properties of the experimental soil site (mean of tow seasons).

Coarse sand %	Fine sand %	Silt %	Clay %		Texture	O.M %	$CaCO_3$ %	
8.99	67.11	10.39	13.51		Sandy loam	0.45	5.00	
pH (1:2:5)	EC (ds/m)	Cations (meq/l)				Anions (meq/l)		
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{-}
8.13	10.08	13.39	20.83	86	0.88	7.93	71	42.17
Available Macronutrients (mg/kg)			Available Micronutrients (mg/kg)					
N	P	K	Fe		Mn	Zn		
35	3.68	169	1.22		2.11	0.62		

Studied traits:

After 105 days from sowing, random samples of sugar beet plants were taken from each sub plot to determine the following traits:

1. Photosynthetic pigments, *i.e.* chlorophyll a, b and carotenoides (mg/g leaf fresh weight), which were determined according to the method of **Wettstein (1957)**.
2. Proline concentration **(u moles/g leaf fresh weight)** was estimated using the method of **Bates, *et al.* (1973)**.

At harvest, the following data were recorded:

Root characteristics:

1. Root length and diameter (cm).
2. Root fresh weight/plant (kg).

Chemical composition:

1. Impurities of juice, *i.e.* α-amino N, Na and K (meq./100 g beet) were determined in the lead acetate extract of fresh macerated root tissue using "Flame photometry" method described by **Browen and Lilliand (1964)**, and then K/Na ratio was calculated.
2. Alpha amino-nitrogen was determined using "ninhydrin hydrindantin" method according to **Cooke and Scott (1993)**.

Technological and quality parameters:

1. Sucrose % (pol %) was polarimaterically determined according to the methods of **Le-Docte, (1927)**.
2. Sugar lost to molasses **(SLM %)** = 0.14 (K + Na) + 0.25 (α-amino - N) + 0.5, **Devillers (1988)**.
3. Extracted Sugar % **(Ex.S%)** = Pol % - SM - 0.6, **Dexter, *et al.* (1967)**.
4. Quality index = Extracted sugar % / Pol%.
5. Impurity index = [10 (N) + 2.5 (K) + 3.5 (Na)] x 100/Sucrose%, **Ryser and Theurer (1971)**.

Yields (ton fad^{-1}):

1. Weight per plot was obtained and used to calculate root yield per-feddan.
2. Sugar yield (ton fad^{-1}) = root yield (ton) x Extracted sugar %.

The collected data of the studied traits were statistically analyzed as shown by **Snedecor and Cochran (1980)**. Treatments means were compared using LSD test at 5% of probability.

RESULTS AND DISCUSSION

1. Photosynthetic pigments and proline concentration:

Results in Tables (2 and 3) clarify that all K- fertilizer treatments exhibited significant increase in Photosynthetic pigments in both seasons compared to the check one. The application of K-fertilizer at 24 kg K_2O fed^{-1} and/or 48 kg K_2O fed^{-1} as soil side dressing of K-sulphate, combined with the foliar application of K-silicate at 3 cm^3 l^{-1} was more effective, and significantly increased chlorophyll a by ٦.٩٠ and ١٥.٥٥ %, chlorophyll b by ٦.٦٧ and ١٥.٤5 and proline concentration by ١٨.٢٩ and ١٣.٧٧%, compared to the soil single application in the 1st season and the 2nd one was the same trend. With insignificant differences between 24 and 48 kg K_2O/fed either in single or combined treatments for chlorophyll a in the 2nd season and proline concentration in both seasons.

These results may be attributed to the role of potassium in the opening and closing of leaf stomata's which control the movement of CO_2 into the plant, in addition to its substantial effect on photosynthesis enzymes activation, and enhancement of photosynthetic rate. Meantime, sulphur element involved in “potassium sulphate” increased the uptake of magnesium, which is an essential element for chlorophyll biosynthesis **(Kastori, et *al.,* 2000)**. These results are in agreement with those reported by **Moustafa and El-Masry (2006)**, who found that increasing rates of K-sulphate from 24 to 48 kg K_2O/fed significantly increased chlorophyll a, b and carotenoides in leaves of sugar beet plant. These results are also in partial agreement with that found by. **(Muhammad, 2013)** showed that the application of K under saline conditions increased proline concentrations in maize. Furthermore, the positive effect of the foliar application of K-element as K-silicate might be associated the role of silicon in increasing the activities of photosynthetic enzymes, chlorophyll content and the accumulation of silicon in leaf causes their erection, which facilitates light penetration Also, it may be due to that potassium and silicon elements, involved in K-silicate, attained a salinity mitigating effect by improving osmolytes and strengthening the enzymatic and non-enzymatic (proline and glycinebetaine) antioxidant defense system (**Muhammad, *et al.* 2014**).

In this connection, **Soudi (2013)** found that foliar spray by potassium silicate at 2000 mg/l increased photosynthetic pigments in leaf of sugar beet. **Cristiane *et al.* (2014),** stated that foliar-applied soluble K-silicate increased concentration and accumulation of proline in potato plants.

Data obtained in Tables (2 and 3) show that the tested sugar beet varieties differed significantly in their content of chlorophyll a, b and carotenoides as well as proline concentration in both seasons, with insignificant difference between Toro and Desperes poly N varieties in chlorophyll a, in the 2nd season and carotenoides in both seasons. Gloria variety surpassed the other two varieties in respect to chlorophyll a, b and carotenoides and accumulates a higher concentration of free proline in response to salinity stresses, in both seasons. These results are in line with those obtained with (**Zaki, *et al.* 2012)**, who recorded significant differences in the contents of chlorophyll a and b among the tested sugar beet varieties under salinity stresses.

Table (2): Chlorophyll a, b and carotenoides concentrations (mg/g leaf fresh weight) of three sugar beet varieties as affected by potassium fertilizer treatments in 2011/2012 and 2012/2013 seasons.

Potassium Treatments	Chlorophyll a							
	2011/2012				2012/2013			
	Gloria	Toro	Desprez poly N	Mean	Gloria	Toro	Desprez poly N	Mean
Control, K1	٢.٣٢	٢.٠٨	٢.٠٣	٢.١٤	٢.٢٤	٢.٣١	٢.٠٦	٢.٢٠
K2	٢.٤٤	٢.٢٤	٢.١٧	٢.٢٨	٢.١٩	٢.٥٨	٢.٢٤	٢.٣٤
K3	٢.٤٦	٢.٢٠	٢.٣٠	٢.٣٢	٢.٣٩	٢.٣٩	٢.٢٦	٢.٣٥
K4	٢.٥٣	٢.٤٣	٢.١٨	٢.٣٨	٢.٥٧	٢.٣٥	٢.٤٣	٢.٤٥
K5	٢.٧٧	٢.٤٠	٢.٢٨	٢.٤٨	٢.٧٤	٢.٢٧	٢.٤٨	٢.٥٠
K6	٣.٣١	٢.٦٣	٢.٣١	٢.٧٥	٢.٧٨	٢.٤٢	٢.٥٩	٢.٦٠
Mean	٢.٦٤	٢.٣٣	٢.٢١		٢.٤٩	٢.٣٩	٢.٣٤	
LSD at 5% level								
K Treatments				0.07				0.12
Varieties (V)				0.05				0.09
K x V				0.13				0.22
	Chlorophyll b							
Control, K1	١.٣٦	١.١٣	٠.٨١	١.١٠	١.٠٠	١.٤١	١.٣٢	١.٢٥
K2	١.٤٠	١.١٢	١.٠٠	١.١٧	١.٣٨	١.٤٥	١.٢٢	١.٣٥
K3	١.٥٥	١.٠٠	١.٠٦	١.٢٠	١.١٩	١.٥٣	١.١٨	١.٣٠
K4	١.٣١	١.٢٤	١.١٥	١.٢٣	١.٦٩	١.٣٥	١.٣١	١.٤٥
K5	١.٥٨	١.١٥	١.١١	١.٢٨	١.٨٥	١.٤١	١.٤٢	١.٥٦
K6	١.٩٣	١.١٦	١.١٩	١.٤٢	٢.٣٣	١.٣٧	١.٥٩	١.٧٦
Mean	١.٥٢	١.١٣	١.٠٥		١.٥٧	١.٤٢	١.٣٤	
LSD at 5% level								
K Treatments				0.06				0.10
Varieties (V)				0.03				0.07
K x V				0.07				0.18
	Carotenoides							
Control, K1	٠.٤٩	٠.٣٢	٠.٤٣	٠.٤١	٠.٥٠	٠.٥٣	٠.٥٨	٠.٥٤
K2	٠.٦١	٠.٤٨	٠.٤٧	٠.٥٢	٠.٧١	٠.٦٨	٠.٦٧	٠.٦٩
K3	٠.٦٤	٠.٤٨	٠.٣٥	٠.٤٩	٠.٦٢	٠.٧٠	٠.٧٤	٠.٦٩
K4	٠.٦٦	٠.٦٠	٠.٥٦	٠.٦١	٠.٨١	٠.٧٦	٠.٧٤	٠.٧٧
K5	٠.٦٩	٠.٦٣	٠.٦٢	٠.٦٥	٠.٩٣	٠.٩٠	٠.٨١	٠.٨٨
K6	٠.٧٩	٠.٧١	٠.٦٩	٠.٧٣	١.٠١	٠.٨٠	٠.٦٨	٠.٨٣
Mean	٠.٦٥	٠.٥٤	٠.٥٢		٠.٧٧	٠.٧٣	٠.٧٠	
LSD at 5% level								
K Treatments				0.05				0.05
Varieties (V)				0.06				0.04
K x V				N.S				0.09

K1, Control: Without K application, K2: 3 cm^3/l K-silicate, K3 & K4: 24 & 48 kg K_2O/fed as K-sulphate, respect., K5: 24 kg K_2O/fed K-sulphate $_+$ 3 cm^3/l K-silicate and K6: 48 kg K_2O/fed K-sulphate $_+$ 3 cm^3/l K-silicate.

Proline accumulation and photosynthetic pigments were significantly affected by the interaction between potassium fertilizer treatments and sugar beet varieties, in both seasons except carotenoides content in the 1st seasons. Supplying Gloria variety with 48 kg fed^{-1} as K-sulphate followed by spraying with 3 cm^3 l^{-1} as K-silicate resulted in the highest contents of chlorophyll a, b in beet leaves, in the two seasons and carotenoides in the 2nd seasons Tables (2 and 3).

Table (3): Proline concentration (u moles/g leaf fresh weight) of three sugar beet varieties as affected by potassium fertilizer treatments in 2011/2012 and 2012/2013 seasons.

Potassium Treatments	Proline concentration							
	2011/2012				2012/2013			
	Gloria	Toro	Desprez poly N	Mean	Gloria	Toro	Desprez poly N	Mean
Control, K1	٣.٥٩	٣.٤٣	٣.٤٥	**٣.٤٩**	٤.١٤	٣.٩٩	٣.٦٣	**٣.٩٢**
K2	٣.٠٨	٢.١١	٢.١٩	**٢.٤٦**	٢.٧٦	١.٥٦	٢.٧١	**٢.٣٤**
K3	٣.٤٠	٢.٥٤	١.٧٦	**٢.٥٧**	٣.٤٨	٢.٩٩	٢.٦٢	**٣.٠٣**
K4	٣.٢٦	٢.٧٠	٢.٣٢	**٢.٧٦**	٣.٣٩	٣.٥٩	٢.٢٠	**٣.٠٦**
K5	٣.٣٤	٣.٠٦	٢.٧١	**٣.٠٤**	٣.٥٣	٣.٥٨	٣.٠٦	**٣.٣٩**
K6	٣.١٩	٣.٣٧	٢.٨٥	**٣.١٤**	٣.٦٢	٣.٥٧	٢.٩٧	**٣.٣٨**
Mean	**٣.٣١**	**٢.٨٧**	**٢.٥٥**		**٣.٤٩**	**٣.٢١**	**٢.٨٧**	
LSD at 5% level K Treatments Varieties (V) K x V				 0.22 0.29 0.71				 0.12 0.07 0.18

K1, Control: Without K application, K2: 3 cm^3/l K-silicate, K3 & K4: 24 & 48 kg K_2O/fed as K-sulphate, respect., K5: 24 kg K_2O/fed K-sulphate + 3 cm^3/l K-silicate and K6: 48 kg K_2O/fed K-sulphate + 3 cm^3/l K-silicate.

٢. Growth traits

Root fresh weight, length and diameter/plant:

Data in Table (4) show that K-fertilization treatments significantly increased root fresh weight, length and diameter/plant in comparison to the control in both seasons. Supplying sugar beet plants with 24 and/or 48 kg K_2O fed^{-1} as soil application of K-sulphate, combined with the foliar application of K-silicate at $3cm^3l^{-1}$ was more effective and significantly increased the growth traits compared to the single soil application in both seasons.

These results may be due to the role of potassium element in enhancing plant growth under stress by improving photosynthesis, osmoregulation, stomata movement, energy transfer, cation-anion balance as mentioned by **Wang *et al.* (2013)**. In addition, sulphur element involved in potassium sulphate may improve growth and alleviate the adverse effects of salinity through, reducing soil pH, increasing the activity of soil microorganism, improves the availability of elements and chemical properties of soil as well as increasing growth characteristics **Mehran and Samad (2013)**. Moreover, the positive effect of K-silicate might be attributed to Si element, which could alleviate salt stress caused by excess sodium and this reflect on better growth and development as explained by **Neseim, *et al.* (2014)**.

Data in the same table showed that the evaluated sugar beet varieties differed significantly in root traits in the two seasons. Gloria variety showed the superiority over the other two varieties in root fresh weight, length and diameter. The variations among the tested sugar beet varieties in these traits might be due to their gene make-up. The difference among sugar beet varieties may be due the variation in their gene make-up and their response to the environmental conditions. These results are in line with those mentioned by **Hozayn *et al* (2013)** who obtained significant differences among the tested sugar beet varieties in root parameters. The interaction between potassium treatments and sugar beet varieties had a significant influence on root length, diameter and fresh weight/plant in both seasons. Supplying Gloria variety with 48 kg fed^{-1} as K-sulphate followed by spraying it with 3 cm^3 l^{-1} K-silicate resulted in the highest mean values of root length, diameter and fresh weight/plant in both seasons Table (4).

Table (4): Root fresh weight/plant (kg), length (cm) and diameter (cm) of three sugar beet varieties as affected by potassium fertilizer treatments in 2011/2012 and 2012/2013 seasons.

Potassium Treatments	Root fresh weight weight/plant							
	2011/2012				2012/2013			
	Gloria	Toro	Desprez poly N	Mean	Gloria	Toro	Desprez poly N	Mean
Control, K1	0.901	٠.7٨٣	٠.6٦٩	٠.7٨٤	0.939	٠.8٢٥	٠.6٦١	٠.8٠٨
K2	١.1٢٥	٠.8٦٧	٠.8٠٥	٠.٩٣٢	١.1٥٠	١.0٨٢	٠.8٥٧	١.0٢٩
K3	١.1٦٠	0.939	٠.8٦٩	٠.٩٨٩	١.2١٤	١.1٢٩	0.900	١.0٨١
K4	١.2٣٧	0.981	0.904	١.0٤١	١.2٥٢	١.1٤٦	١.0٣٧	١.1٤٥
K5	١.2١٠	١.0٤٠	١.0٢٨	١.0٩٣	١.2١٧	١.2٤١	١.0٢٠	١.1٥٩
K6	١.2٥٥	١.0٦٥	١.0٢٨	١.1١٦	١.2٦٥	١.2٠٨	١.1٠٦	١.1٩٣
Mean	١.1٤٨	0.946	٠.8٨٤		١.1٧٣	١.1٠٥	٠.٩٣٠	
LSD at 5% level K Treatments Varieties (V) K x V				 0.034 0.019 0.046				 0.027 0.023 0.055
Root length								
Control, K1	٢٠.١٠	٢٢.٢٣	١٩.٤٣	20.59	٢٤.٧٣	٢٠.٤٠	١٩.٧٣	21.62
K2	٢٠.٠٠	٢٥.٥٣	٢٠.٥٣	22.02	٢٦.٦٥	١٨.٣١	٢١.٤٦	22.14
K3	٢١.٨٦	٢٤.٣١	١٨.٦٠	21.59	٢٦.٧٨	٢٠.٢٠	٢٠.٣٣	22.44
K4	٢٣.٨٧	٢٥.٣٣	١٩.٩٣	23.04	٢٨.٤٥	١٨.٦٥	٢٤.٣٣	23.81
K5	٢٥.٤٣	٢٥.٢٠	١٨.٨٠	23.14	٢٦.٩٦	٢١.٢١	٢٣.٢٦	23.81
K6	٢٨.٠٣	٢٦.١٣	٢١.١٣	25.10	٢٩.٣٧	٢١.١٣	٢٦.٢٣	25.58
Mean	٢٣.٢٢	٢٤.٧٩	١٩.٧٤		٢٧.١٦	١٩.٩٨	٢٢.٥٦	
LSD at 5% level K Treatments Varieties (V) K x V				 0.28 0.16 0.39				 0.35 0.09 0.22
Root diameter								
Control, K1	١١.٠٩	٧.٨٥	٧.٩٠	٨.٩٥	٩.٥٣	١٠.٤٩	٨.٥٨	٩.٥٣
K2	١١.٣٠	٩.٧٥	٩.٢٥	١٠.١٠	١٠.٥١	١١.٠٢	٩.٥٧	١٠.٣٧
K3	١١.٣٩	١٠.٣٦	٩.٩٩	١٠.٥٨	١١.٥٣	١١.٢٢	٩.٤٤	١٠.٧٣
K4	١١.٤٣	١١.٠٤	٩.٨٥	١٠.٧٧	١١.٨٦	١١.٢٨	١١.٠٩	١١.٤١
K5	١١.٨٩	١٠.٨٠	١٠.٣١	١١.٠٠	١٢.٤٨	١١.١٢	١١.١٤	١١.٥٨
K6	١٢.٨٣	١١.٨٣	١١.٨٥	١٢.١٧	١٢.٣٧	١١.٨٦	١٠.٩٤	١١.٧٢
Mean	١١.٦٥	١٠.٢٧	٩.٨٦		١١.٣٨	١١.١٧	١٠.١٣	١١.٣٨
LSD at 5% level K Treatments Varieties (V) K x V				 0.15 0.16 0.40				 0.17 0.07 0.17

K1, Control: Without K application, K2:3 cm^3/l K-silicate, K3 & K4: 24 & 48 kg K_2O/fed as K-sulphate, respect., K5: 24 kg K_2O/fed K-sulphate+3 cm^3/l K-silicate and K6: 48 kg K_2O/fed K-sulphate+3 cm^3/l K-silicate.

3. Juice quality and technological traits

3.1. Juice impurities:

Data in Table (5) show that K-fertilization treatments significantly decreased Na roots content comparison to the control in both seasons.

The application of K-fertilizer at 24 kg K_2O fed^{-1} or 48 kg K_2O fed^{-1} as soil side dressing of K-sulphate, combined with the foliar application of K-silicate at 3 cm^3 l^{-1} significantly reduced root Na content by 13.97 and 10.00 %, and increased K content by 8.54 and 4.76%, compared to the soil single application in the 1st season and the 2nd one was the same trend for Na content.

Reducing Na content in juice may be due to role of potassium and silicon in increasing enzyme activity, and concentration of soluble substances in the xylem, resulting in limited sodium adsorption by plants **(Liang, 1999)**. These results are in agreement with those obtained by **Ahmad (2013)**, who found that exogenous application of potassium silicate significantly decreased sodium% in wheat plant under salt stress.

Data in Table (5) show significant differences among sugar beet varieties in potassium content in both seasons and Na in the 2nd one. Gloria variety was more responsive to soil salinity, where it recorded the lowest Na content in root juice compared to the other two varieties in 2nd season. The difference among the three sugar beet varieties could be due to the variation in their gene make-up and their response to the environmental conditions and potassium fertilization.

These results are in line with those mentioned by **Ahmed, *et al*. (2012)** and **Hozayn *et al* (2013)**, who found significant differences among the tested sugar beet varieties in quality traits.

Table (5): Impurities contents (Na, K and α-amino N) of three sugar beet varieties as affected by potassium fertilizer treatments in 2011/2012 and 2012/2013 seasons.

Potassium Treatments	Na (meq./100 g beet)							
	2011/2012				2012/2013			
	Gloria	Toro	Desprez poly N	Mean	Gloria	Toro	Desprez poly N	Mean
Control, K1	١.٨٦	١.٨٩	١.٩٠	١.٨٨	١.٨٢	١.٨٧	٢.٠١	١.٩٠
K2	١.٧٩	١.٨٥	١.٨٣	١.٨٢	١.٨٢	١.٨٠	١.٩٠	١.٨٤
K3	١.٨٠	١.٧٧	١.٧٩	١.٧٩	١.٧٠	١.٧٦	١.٧٢	١.٧٣
K4	١.٧٣	١.٧٠	١.٦٦	١.٧٠	١.٥٩	١.٨١	١.٦٩	١.٧٠
K5	١.٥٤	١.٥٩	1.51	١.٥٤	١.٥٣	١.٥٦	١.٦٢	١.٥٧
K6	١.٥٠	١.٥٣	١.٥٥	١.٥٣	١.٤٧	١.٦٢	١.٥١	١.٥٣
Mean	١.٧٠	١.٧٢	١.٧٠		١.٦٥	١.٧٤	١.٧٤	
LSD at 5% level								
K Treatments				0.04				0.04
Varieties (V)				NS				0.03
K x V				NS				NS
K (meq./100 g beet)								
Control, K1	٣.٥٤	٣.٣٦	٣.٣٧	٣.٤٢	٣.٦١	٣.٧٨	٣.٦٦	٣.٦٨
K2	٣.٦٨	٣.٧١	٣.٧٥	٣.٧١	٣.٧١	٣.٨٢	٣.٨٦	٣.٨٠
K3	٣.٨٦	٣.٩٣	٤.١٤	٣.٩٨	٣.٩٦	٣.٨٠	٤.٠٢	٣.٩٣
K4	٤.١٩	٤.١٣	٤.٢٩	٤.٢٠	٣.٧٩	٣.٩٣	٤.١٧	٣.٩٦
K5	٣.٦٤	٤.٦٩	٤.٦٢	٤.٣٢	٣.٨٣	٣.٩٥	٤.١٣	٣.٩٧
K6	٤.٤٨	٤.٣٢	٤.٤١	٤.٤٠	٣.٩٦	٤.١٥	٤.١٠	٤.٠٧
Mean	٣.٩٠	٤.٠٢	٤.١٠	.	٣.٨١	٣.٩١	٣.٩٩	.
LSD at 5% level								
K Treatments				0.11				0.12
Varieties (V)				0.07				0.10
K x V				0.17				0.24
α- amino N (meq./100 g beet)								
Control, K1	١.٦٦	١.٥٣	١.٤٣	١.٥٤	١.٦٤	١.٥٣	١.٥٥	١.٥٧
K2	١.٥١	١.٤٦	١.٥٣	١.٥٠	١.٥٠	١.٥٣	١.٤٩	١.٥١
K3	١.٥٥	١.٥٤	١.٤٥	١.٥١	١.٥٠	١.٥١	١.٤٧	١.٤٩
K4	١.٥٦	١.٦٠	١.٤٥	١.٥٤	١.٤٣	١.٥٢	١.٤٥	١.٤٧
K5	١.٥٨	١.٥٣	١.٣٩	١.٥٠	١.٤١	١.٤٨	١.٤٣	١.٤٤
K6	١.٥٣	١.٥٨	١.٤١	١.٥١	١.٤٠	١.٤٢	١.٤٢	١.٤١
Mean	١.٥٧	١.٥٤	١.٤٤	.	١.٤٨	١.٥٠	١.٤٧	.
LSD at 5% level								
K Treatments				0.03				0.09
Varieties (V)				NS				NS
K x V				NS				NS

K1, Control: Without K application, K2: 3 cm^3/l K-silicate, K3 & K4: 24 & 48 kg K_2O/fed as K-sulphate, respect., K5: 24 kg K_2O/fed K-sulphate + 3 cm^3/l K-silicate and K6: 48 kg K_2O/fed K-sulphate + 3 cm^3/l K-silicate.

3.2. Some Technological traits:

Results in Table (6 and 7) indicated that all K-fertilizer treatments had a significant effect on sucrose%, extracted sugar%, sugar losses in molasses% quality index and impurity index, in both seasons.

Table (6): Sucrose, Extracted sugar% and impurities characters of three sugar beet varieties as affected by potassium fertilizer treatments in 2011/2012 and 2012/2013 seasons.

Potassium Treatments	Sucrose%							
	2011/2012				2012/2013			
	Gloria	Toro	Desprez poly N	Mean	Gloria	Toro	Desprez poly N	Mean
Control, K1	١٧.٣٥	١٥.٣٣	١٥.٤٦	١٦.٠٥	١٦.٩٧	١٥.٦٥	١٦.٢١	١٦.٢٨
K2	١٨.٨٦	١٧.٠٢	١٧.٥٥	١٧.٨١	١٧.٦١	١٦.١٢	١٧.٢١	١٦.٩٨
K3	١٩.٠٦	١٧.٠٩	١٧.٥٣	١٧.٩٠	١٧.٩٨	١٦.٦٨	١٧.١٢	١٧.٢٦
K4	١٩.٠٥	١٧.٤٢	١٧.٧٢	١٨.٠٦	١٨.٧٥	١٧.٦٥	١٧.٨٢	١٨.٠٧
K5	١٩.٢٦	١٧.٣١	١٧.٤٢	١٨.٠٠	١٩.٩٢	١٧.٤٠	١٧.٥٩	١٨.٣٠
K6	١٩.٢٦	١٧.٨٠	١٨.٨١	١٨.٦٢	٢٠.٠٦	١٧.٦١	١٩.١٠	١٨.٩٢
Mean	١٨.٨١	١٦.٩٩	١٧.٤٢		١٨.٥٥	١٦.٨٥	١٧.٥١	
LSD at 5% level K Treatments Varieties (V) K x V				0.23 0.14 0.34				0.39 0.37 0.51
Extracted sugar%								
Control, K1	١٥.٠٨	١٣.١١	١٣.٢٧	١٣.٨٢	١٤.٧٠	١٧.٧١	١٥.٧١	١٤.٠٠
K2	١٦.٦١	١٤.٧٨	١٥.٢٨	١٥.٥٦	١٦.٨٦	١٥.٥٤	١٤.٩٣	١٤.٧١
K3	١٦.٧٨	١٤.٨١	١٥.٢٤	١٥.٦١	١٥.٣٥	١٥.٣٧	١٣.٨٥	١٤.٩٩
K4	١٦.٧٣	١٥.١١	١٥.٤٢	١٥.٧٥	١٧.٨٥	١٦.٥٤	١٥.٣٦	١٥.٨١
K5	١٧.٠٤	١٤.٩٥	١٥.١٢	١٥.٧٠	١٣.٩٣	١٥.٣٣	١٤.٨٥	١٦.٠٧
K6	١٦.٩٤	١٥.٤٨	١٦.٥٣	١٦.٣٢	١٣.٣٨	١٥.١٦	١٤.٤٢	١٦.٦٩
Mean	١٦.٥٣	١٤.٧١	١٥.١٤		١٦.٣١	١٤.٥٩	١٥.٢٤	
LSD at 5% level K Treatments Varieties (V) K x V				0.38 0.21 0.52				0.23 0.13 0.33
K/Na Ratio								
Control, K1	1.90	1.78	1.77	1.82	1.98	2.02	1.82	1.94
K2	2.0٦	2.01	2.05	2.0٤	2.0٤	2.12	2.03	2.07
K3	2.14	2.22	2.31	2.22	2.33	2.16	2.34	2.27
K4	2.42	2.43	2.58	2.47	2.38	2.17	2.47	2.33
K5	2.36	2.95	3.٠٨	2.80	2.50	2.53	2.55	2.53
K6	2.9٩	2.82	2.85	2.8٨	2.69	2.56	2.72	2.66
Mean	2.29	2.34	2.41	.	2.31	2.25	2.29	.

K1, Control: Without K application, K2: 3 cm^3/l K-silicate, K3 & K4: 24 & 48 kg K_2O/fed as K-sulphate, respect., K5: 24 kg K_2O/fed K-sulphate + 3 cm^3/l K-silicate and K6: 48 kg K_2O/fed K-sulphate + 3 cm^3/l K-silicate.

Application of K-fertilizer 48 kg K_2O fed^{-1} as soil application of K-sulphate, combined with the foliar application of K-silicate at 3 cm^3 l^{-1}, significantly increased sucrose% and extracted sugar%. On the contrary significantly reduced impurity index compared to the soil single application in both season

Table (7): Some technological characters of three sugar beet varieties as affected by potassium fertilizer treatments in 2011/2012 and 2012/2013seasons.

Potassium Treatments	Sugar lost to molasses%							
	2011/2012				2012/2013			
	Gloria	Toro	Desprez poly N	Mean	Gloria	Toro	Desprez poly N	Mean
Control, K1	١.٦٧	١.٦٢	١.٥٩	**١.٦٣**	١.٦٧	١.٦٠	١.٦٧	**١.٦٨**
K2	١.٦٤	١.٦٤	١.٦٦	**١.٦٥**	١.٦٤	١.٦٨	١.٦٨	**١.٦٧**
K3	١.٦٨	١.٦٨	١.٦٩	**١.٦٩**	١.٦٦	١.٦٨	١.٦٧	**١.٦٧**
K4	١.٧٢	١.٧٢	١.٧٠	**١.٧١**	١.٦١	١.٦١	١.٦٥	**١.٦٦**
K5	١.٦٢	١.٧٦	١.٧٠	**١.٧٠**	١.٦٨	١.٦٦	١.٦٧	**١.٦٤**
K6	١.٧٢	١.٧١	١.٦٩	**١.٧١**	١.٦٧	١.٦٤	١.٦٦	**١.٦٤**
Mean	**١.٦٨**	**١.٦٩**	**١.٦٧**		**١.٦٣**	**١.٦٦**	**١.٦٧**	
LSD at 5% level K Treatments Varieties (V) K x V				**0.02 0.02 NS**				**0.01 0.01 0.03**
Quality index								
Control, K1	٨٦.٩٠	٨٥.٥٣	٨٥.٨٠	**٨٦.٠٨**	٨٦.٦٢	٨٨.٩٢	٨٧.٣٨	**٨٦.٠٠**
K2	٨٨.١٠	٨٦.٨١	٨٧.١٠	**٨٧.٣٤**	٨٨.٢٧	٨٧.١٨	٨٦.٧٦	**٨٦.٦٣**
K3	٨٨.٠٤	٨٦.٦٣	٨٦.٩٢	**٨٧.٢٠**	٨٧.١٤	٨٧.٠٧	٨٥.٩٢	**٨٦.٨٦**
K4	٨٧.٨٣	٨٦.٧١	٨٧.٠٤	**٨٧.١٩**	٨٨.٩٨	٨٨.٢١	٨٧.٢٣	**٨٧.٤٩**
K5	٨٨.٤٧	٨٦.٣٥	٨٦.٧٨	**٨٧.٢٠**	٨٥.٩٢	٨٧.١٣	٨٦.٧٣	**٨٧.٧٢**
K6	٨٧.٩٥	٨٧.٠٠	٨٧.٨٤	**٨٧.٦٠**	٨٥.٤٦	٨٧.١١	٨٦.٤٧	**٨٨.١٣**
Mean	**٨٧.٨٨**	**٨٦.٥١**	**٨٦.٩١**		**٨٧.٨٩**	**٨٦.٥٣**	**٨٧.٠٠**	
LSD at 5% level K Treatments Varieties (V) K x V				**0.24 0.20 0.44**				**0.21 0.10 0.25**
Impurity index								
Control, K1	١٨٤.٥	١٩٨.١	١٨٩.٨	**١٩٠.٨**	١٨٧.٤	٢٠٠.١	١٩٥.٧	**١٩٤.٤**
K2	١٦٢.١	١٧٨.٤	١٧٦.٩	**١٧٢.٥**	١٧٣.٩	١٩٣.٥	١٨١.٢	**١٨٢.٩**
K3	١٦٥.١	١٨٤.١	١٧٧.٤	**١٧٥.٥**	١٧١.٨	١٨٤.٦	١٨٠.١	**١٧٨.٨**
K4	١٦٨.٨	١٨٥.١	١٧٥.٣	**١٧٦.٤**	١٥٦.٦	١٧٧.٦	١٧٣.٠	**١٦٩.٠**
K5	١٥٧.٥	١٨٨.٣	١٧٦.١	**١٧٣.٩**	١٤٦.٢	١٧٣.٣	١٧٢.٣	**١٦٣.٩**
K6	١٦٥.١	١٧٩.٧	١٦٢.٥	**١٦٩.١**	١٤٤.٦	١٧٢.٠	١٥٥.٦	**١٥٧.٤**
Mean	**١٦٧.٢**	**١٨٥.٦**	**١٧٦.٣**	**.**	**١٦٣.٤**	**١٨٣.٥**	**١٧٦.٣**	**.**
LSD at 5% level K Treatments Varieties (V) K x V				**3.4 2.1 5.1**				**4.4 3.7 9.0**

K1, Control: Without K application, K2: 3 cm^3/l K-silicate, K3 & K4: 24 & 48 kg K_2O/fed as K-sulphate, respect., K5: 24 kg K_2O/fed K-sulphate + 3 cm^3/l K-silicate and K6: 48 kg K_2O/fed K-sulphate + 3 cm^3/l K-silicate.

These results may be due to the salt tolerance in plants increased by increasing K levels which leads to increasing K/ Na ratio in plant cells **(Akinci *et al.*, 2004).**

Significant differences among sugar beet varieties were found in SLM%, QI, impurity index, sucrose% and extracted sugar% in both seasons. Data showed that Gloria variety superiority over the other tested varieties in quality index, sucrose%

and extracted sugar% in both seasons and recorded the lowest impurity index Table (6 and 7).

The interaction between potassium treatments and sugar beet varieties had asignificant effect on quality index, impurity index, sucrose% and extracted sugar% in both seasons. Fertilizing Gloria variety with 48 kg K_2O fed^{-1} given as soil application, along with spraying 3cm^{3}l^{-1} K-silicate resulted in the highest sucrose% in both seasons Tables (6 and 7).

4. Root and sugar yields (ton fed^{-1}):

Data in Table (8) indicated that all K-fertilizer treatments significantly increased root and sugar yields/fed in both seasons compared to the untreated one. The application of K-fertilizer at 24 and/or 48 kg K_2O fed^{-1} as soil side dressing of K-sulphate, along with the foliar application of K-silicate at 3 cm^3 l^{-1} significantly increased root yield (ton fed^{-1}) by (8.19 and 10.24 %), sugar yield (ton fed^{-1}) by (8.83and 13.85%) in the 1st season compared to the soil single application, and the 2nd one was the same trend, without significant variances between 24 and 48 kg K_2O/fed as soil application of K-sulphate for root yield in both season, and sugar yield in the 1st seasons**.**

The positive effect of potassium on yield could be attributed to the stimulatory effect of K on rate of photosynthesis as shown in Table (2), as well as, transport of the photosynthetic product from the leaves to the storage root which reflects on yields. Furthermore, positive trends of plants selectivity for K over Na **Munns (2002)** and the increases in yields with increasing K due to increased K/Na ratios as shown in Table (6) in addition the stimulator effect of potassium silicate which contains silicon, might be associated with silicon decreased plant Na uptake increased potassium and consequently improved, yields (**Muhammad, *et al.* 2014)**. These results are in agreement with those obtained with **Salami and Saadat (2013)** showed that increasing K rates significantly increased root and sugar yields /fed of sugar beet.

Data recorded in Table (8) showed significant differences among sugar beet varieties in root and sugar yields (ton fed^{-1}) in both seasons**,** Gloria variety showed the superiority over the other two varieties in root and sugar yields in the two seasons**.**

The difference among sugar beet varieties may be due to the variation in the gene make-up and their response to the environmental conditions, the obtained results are in harmony with those of **Ahmed *et al*., (2012)** indicated that beet yield differed with different cultivars under salinity conditions.

The interaction between potassium treatments and sugar beet varieties had a significant effect on root and sugar yields in both seasons.
Fertilizing Gloria variety with 48 kg K_2O fed^{-1} in the form of potassium sulphate, given as soil application, along with spraying 3cm l^{-1} K-silicate resulted in the highest root yield in the two seasons and sugar yield in the 1st seasons.

Table (8): Root and recoverable sugar yield (ton fed^{-1}) of three sugar beet varieties as affected by potassium fertilizer treatments in 2011/2012 and 2012/2013 seasons.

Potassium Treatments	Root yield (ton/fed)							
	2011/2012				2012/2013			
	Gloria	Toro	Desprez poly N	Mean	Gloria	Toro	Desprez poly N	Mean
Control, K1	١٨.٨٩	١٧.٤٦	١٥.٦٥	١٧.٣٣	١٧.٣٠	١٦.٨٤	١٦.٥٧	١٦.٩٠
K2	١٩.٢٩	١٧.٣٠	١٧.٣٩	١٧.٩٩	١٨.٤٣	١٧.٥٢	١٧.٢٧	١٧.٧٤
K3	١٩.٦٨	١٨.٠٠	١٦.٥٤	١٨.٠٧	١٩.٩٧	١٨.٦١	١٨.١٥	١٨.٩١
K4	١٩.٧٦	١٨.٨٩	١٧.٥٩	١٨.٧٥	٢٠.٤٥	١٨.٦٤	١٨.٠٨	١٩.٠٦
K5	٢١.٤٢	١٩.٣٧	١٧.٨٥	١٩.٥٥	٢٢.٤٠	١٩.٧٧	١٨.٣٦	٢٠.١٨
K6	٢٢.٠٥	٢٠.٤٢	١٩.٥٣	٢٠.٦٧	٢٢.٧١	٢٠.٥٧	١٩.٤٢	٢٠.٩٠
Mean	٢٠.١٨	١٨.٥٧	١٧.٤٣		٢٠.٢١	١٨.٦٦	١٧.٩٧	
LSD at 5% level								
K Treatments				0.70				0.34
Varieties (V)				0.23				0.17
K x V				0.57				0.43
Recoverable sugar yield (ton/fed)								
Control, K1	٢.٨٥	٢.٢٩	٢.٠٨	٢.٤٠	٢.٥٤	٣.٩٧	٣.١٤	٢.٣٧
K2	٣.٢١	٢.٥٦	٢.٦٦	٢.٨١	٣.٢٧	٢.٨١	٢.٥٨	٢.٦١
K3	٣.٣٠	٢.٦٦	٢.٥٢	٢.٨٣	٣.١٦	٢.٨٦	٢.٤٣	٢.٨٤
K4	٣.٣١	٢.٨٥	٢.٧١	٢.٩٦	٤.٠٥	٣.٣٨	٢.٨٣	٣.٠٢
K5	٣.٦٥	٢.٩٠	٢.٧٠	٣.٠٨	٢.٣١	٢.٨١	٢.٦٩	٣.٢٦
K6	٣.٧٤	٣.١٦	٣.٢٣	٣.٣٧	٢.٢٥	٣.٠٠	٢.٦٨	٣.٥٠
Mean	٣.٣٤	٢.٧٤	٢.٦٥		٣.٣٢	٢.٧٣	٢.٧٥	
LSD at 5% level								
K Treatments				0.15				0.10
Varieties (V)				0.06				0.04
K x V				0.14				0.11

K1, Control: Without K application, K2: 3 cm^3/l K-silicate, K3 & K4: 24 & 48 kg K_2O/fed as K-sulphate, respect., K5: 24 kg K_2O/fed K-sulphate + 3 cm^3/l K-silicate and K6: 48 kg K_2O/fed K-sulphate + 3 cm^3/l K-silicate.

REFERENCES

Abdel-Mawla, S.E. and I. Zanouny (2004). Response of sugar beet (*Beta vulgaris, L.*) to potassium application and irrigation with saline water. Assuit Univ. Bull. Environ. Res., **7** (1): 123-136.

Ahmad, B. (2013). Interactive effects of silicon and potassium nitrate in improving salt tolerance of wheat. J. Integrative Agric., **13** (9):1889-1899.

Ahmed, S.; M. Zubair; N. Iqbal; N.M. Cheema and K. Mahmood (2012). Evaluation of sugar beet hybrid varieties under Thal-Kumbi in Pakistan. J. Agric. Biol., **14** (4): 605-608

Akinci, S.; K. Yilmaz and I.E. Akinci (2004). Response of tomato (*Lycopersicon esculentum*, Mill.) to salinity in the early growth stages for agricultural cultivation in saline environments. J. Environ. Biol., **25** (3): 351-357.

Ali, S.P.P.; P. Mohanty and J. Matysik (2001). Effect of proline on the production of singlet oxygen. Amino Acid, **21**, 195-200.

Bates, L.S.; R.P. Waldran and I.D. Teare (1973). Rapid determination of free proline for water studies. Plant Soil, **39**: 205 -208.

Bednarz, C.W.; D.M. Oosterhuis and R.D. Evans (1998). Leaf photosynthesis and carbon isotope discrimination of cotton in response to potassium deficiency. Environ. Expt. Bot., **39**: 131-139.

Browen, J.D. and D. Lilliand (1964). Rapid determination of potassium and sodium in plant materials and soil extracts by flame photometeric. Proc. Amer. Soc. Hort. Sci., **48**:341-346.

Cooke, D.A. **and R. K. Scott (1993)**. The sugar beet crop. Chapman and Hall London, pp.262-265.

Cottenie, A.; M. Verloo; G. Velghe and R. Cameriynck (1982). "Chemical Analysis of plant and soil." Laboratory of Analytical and Agrochemistry, State Univ., Ghent, Belgium.

Cristiane, P.; P. Rogério; B. Soratto; B. Fernando; and M.F. Adalton (2014). Foliar or soil applications of silicon alleviate water-deficit stress of potato plants. Agron. J., **106** (6): 2325-2334.

Devillers, P. (1988). Previsoion du sucre melasse Scurries francases **129**: 190-200. In: **Cooke, D.A**. **and R. K. Scott (1993)**. The sugar beet crop. Chapman and Hall London, pp.262-265.

Dexter, S.T.; M.G. Frakes and F.W. Snyder (1967). A rapid and practical method of determining extractable white 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. [C.F. **Cooke, D.A**. **and R. K. Scott (1993)**. The sugar beet crop. Chapman and Hall London, pp.262-265].

Draycott, A.P. (2006). Sugar Beet, UK: Blackwell publishing Ltd, Oxford, P. 474.

Hozayn, M.; A.A. Abd El-Monem and A.A. Bakery (2013). Screening of some exotic sugar beet cultivars grown under newly reclaimed sandy soil for yield and sugar quality traits. J. Appl. Sci. Res., **9** (3): 2213-2222.

Hussain Z.; R.A. Khattak; M. Irshad and Q. Mahmoud (2014). Sugar beet (*Beta vulgaris* L.) response to diammonium phosphate and potassium sulphate under saline-sodic conditions. Soil Use and Management, / 320-327.

Jamil, M.; S.U. Rehman; K.J. Lee; J.M. Kim and H.K. Rha (2007). Salinity induced growth PS_2 photochemistry and chlorophyll content in radish. Scientia Agricola, **64**: 570-573.

Kassem, H.A. (2012). The response of date palm to calcareous soil fertilization. J. Soil Sci. Plant Nut., **12**: 45-58.

Kastori, R.; M. Plescnicar; I. Arsenijevic-Maksimovie; N. Petrovic; D. Pankovic and Z. Sakac (2000). Photosynthetic, chlorophyll fluorescence and water relation of young sugar beet plants as affected by sulphur supply. J. Plant Nutr., **23** (3), 1049-1073.

Le-Docte, A. (1927). Commercial determination of sugar beet in the beet roots using Sachs Le-Docte process. Int. Sugar J., **29**: 488-492.

Liang, Y. C. (1999). Effect of silicon on enzyme activity and sodium, potassium and calcium concentration in barley under salt stress. Plant and Soil, **209**: 217-224.

Mehran, S. and S. Samad (2013). Study of potassium and nitrogen fertilizer levels on the yield of sugar beet in jolge cultivar. J. Nov. Appl. Sci., **2** (4): 94-100.

Moustafa, Shafika N. and A.A. El–Masry (2006). Effect of nitrogen and potassium fertilization with or without spraying by iron combined with manganese on some physio-chemical properties productivity and quality of sugar beet crop. Ann. Agric. Sci., **44** (4): 1431-1446.

Muhammad, A. (2013). Effect of potassium nutrition on solute accumulation, ion composition and yield of maize hybrids grown under saline conditions. J. Plant Nutrition, **36,** 143–163.

Muhammad, A. A.; A. Tahira; M.K. Muhammad; M.B. Rashad; M. Neil and A.S. Muhammad (2014). Foliar spray of phyto-extracts supplemented with silicon: An Efficacious Strategy to Extenuate the Salinity-induced Deleterious Effects in Pea (*Pisum sativum,* L.). Amer. Soc. Horti. Sci. (ASHS) Ann. Conf., July -27-31.

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

Neseim, M.R.; A.Y. Amin and M.M.S. El-Mohammady (2014). Effect of potassium applied with foliar spray of yeast on sugar beet growth and yield under drought stress. Gio. Adv. Res. J. Agric. Sci., **3** (8): 211-222.

Ryser, George K. and J. C. Theurer (1971). Impurity index selections on individual sugar beet J. Amer Soc. Sugar Beet Technol.16:399-407

Salami, M. and S. Saadat (2013). Study of potassium and nitrogen fertilizer levels on the yield of sugar beet in jolge cultivar. J. Appl Sci., 2(4): 94-100.

Snedecor, G.W. and W.G. Cochran (1980). Statistical Methods. 7th Ed. The Iowa State Univ. Press Amer. Iowa, USA.

Soudi Amal, M.K. (2013). Effect of two antitranspirants on growth and quality of sugar beet under different levels of soil moisture deficit. Egypt. J. Appl. Sci., **28** (5) 305-318.

Wang, M.; Q. Zheng; Q. Shen and S. Guo (2013). The critical role of potassium in plant stress response. Int. J. Molecular Sci., **14** (4):7370-7390.

Wettstein, D. (1957). Chlorophyll, Letal_und der submikrosvopische formmech, sall-plastiden. Exptl Cell Ser., **12**: 427-433.

Zaki Nabila, M.; Amal G. Ahmed; M. S. Hassanein and M. M. Tawfik (2014). Foliar application of potassium to mitigate the adverse impact of salinity on some sugar beet varieties. 1: effect on growth and some physiological aspects. J. Appl. Sci. Res., **8** (8): 4405-4416.

Zayed, B.A. (2003). Performance of some rice cultivars as affected by irrigation and potassium fertilizer treatments under saline soil conditions. Ph.D. Thesis, Fac. Agric., Mansoura Univ., Egypt.

إستجابة بعض أصناف بنجر السكر للإضافة الأرضية والورقية المتكاملة للبوتاسيوم فى التربة الملحية

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أقيمت تجربتان حقليتان بمنطقة جلبانة بسهل الطينة (تقع بين خطى الطول ٣٢.٢٠ و٣٢.٣٣ درجة شرقاً و دائرتى عرض (٣٠.٥٧ و٣١.٠٤ درجة شمالاً) بمحافظة شمال سيناء، خلال موسمي ٢٠١٢/٢٠١١ و٢٠١٣/٢٠١٢ لدراسة تأثير الإضافة المتكاملة للسماد البوتاسى على بعض المكونات الكيميائية ونمو وحاصل وجودة بنجر السكر تحت ظروف الأراض الملحية.

إشتمل هذا البحث على ثمانية عشرة معاملة تمثل التوافقات بين ثلاثة أصناف عديدة الأجنة من بنجر السكر (جلوريا وتورو وديسبريز بولى إن) وستة معاملات من التسميد البوتاسى والتي كانت:

1- المقارنة (بدون إضافة بوتاسيوم).
٢- ٣سم٣ للتر في صورة سيليكات بوتاسيوم رشاً ورقياً.
٣- ٢٤ كجم بو٢أ/فدان في صورة كبريتات بوتاسيوم كإضافة أرضية.
٤- ٤٨ كجم بو٢أ/فدان في صورة كبريتات بوتاسيوم كإضافة أرضية.
٥- ٢٤ كجم بو٢أ/فدان في صورة كبريتات بوتاسيوم كإضافة أرضية + ٣ سم٣ للتر سيليكات بوتاسيوم.
٦- ٤٨ كجم بو٢أ/فدان في صورة كبريتات بوتاسيوم كإضافة أرضية + ٣ سم٣ للتر سيليكات بوتاسيوم.

استخدم تصميم القطع المنشقة مرة واحدة فى الموسمين فى ثلاث مكررات، حيث وضعت معاملات البوتاسيوم في القطع الرئيسية، فى حين وزعت الأصناف عشوائياً في القطع الشقية.

أشارت النتائج المتحصل عليها إلى ما يلى:

- أدي التسميد الأرضى و/أو الورقي بالبوتاسيوم إلى تخفيف التأثير الضار لملوحة التربة و زيادة معنوية فى متوسطات الكلوروفيل (أ)، (ب)، والكاروتينويدات، الطول والقطر والوزن الطازج للجذر/النبات، وكذا زيادة النسب المئوية للسكروز والسكر المستخلص ودليل الجودة وحاصلى الجذور والسكر /فدان وتقليل محتوى الجذور من الصوديوم وزيادة نسبة البوتاسيوم/الصوديوم في الجذور مقارنة بالكنترول فى كلا الموسمين.
- كانت الإضافة الأرضية لكبريتات البوتاسيوم بمعدل 24 أو ٤٨ كجم بو٢أ/فدان مع التسميد الورقى بسيليكات البوتاسيوم بتركيز ٣ سم٣/لتر أكثر تأثيراً، وأدت إلي زيادة معنوية فى حاصل الجذور بنسبة (٨.١٩، ١٠.٢٤%) وزيادة حاصل السكر بنسبة (٨.٨٣، ١٣.٨٥%) فى الموسم الأول مقارنة بإضافة كبريتات البوتاسيوم منفردة، وسُجّل نفس الإتجاه في الموسم الثاني.
- أدت الإضافة الأرضية لكبريتات البوتاسيوم بمعدل ٤٨ كجم بو٢أ/فدان + الرش الورقي ٣ سم٣/لتر من سيليكات البوتاسيوم إلى زيادة معنوية في دليل الجودة والنسبة المئوية للسكروز وخفضت دليل الشوائب في كلا الموسمين مقارنة بإضافة كبريتات البوتاسيوم منفردة.
- أظهر الصنف جلوريا تفوقاً علي الصنفين الآخرين في كلورفيل (أ)و (ب) وتركيز البرولين والقطر والوزن الطازج للجذر/النبات، وحاصلى الجذور والسكر/الفدان، وكذا النسب المئوية للسكروز والسكر المستخلص فى كلا الموسمين ونسبة البوتاسيوم/الصوديوم في الموسم الثاني.
- تحت ظروف هذا البحث، يمكن التوصية بزراعة صنف بنجر السكر "جلوريا" مُسمداً بتوليفة من كبريتات البوتاسيوم بمعدل ٤٨ كجم بو٢أ/فدان كإضافة أرضية مع الرش الورقي بسليكات البوتاسيوم بتركيز٣سم٣/لتر للحصول على أعلى حاصل جذور/الفدان وأعلى نسبة مئوية للسكروز وأقل محتوي للصوديوم فى العصير بمنطقة سهل الطينة بشمال سيناء.