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Transplanting of Sugar Beet with Soil Drench by Potassium Humate or Potassium Silicate Enhanced Plant Growth and Productivity under Saline Soil Conditions

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ABSTRACT

Two field experiments were conducted during seasons of 2013/2014 & 2014/2015 on sugar beet plant cultivated either by transplanting or direct seeding under saline soil conditions (11.5 dsm^{-1}) at Sahl El-Tina, North Sinai region, Egypt. Experimental Station of Desert Research Center (DRC). The effect of applied potassium humate (4, 8 g/L^{-1}) and potassium silicate (4, 8 g/L^{-1}) as soil drench for six time with 15 days intervals started from 60 days after sowing were studied. Transplanting sugar beet plant revealed an increment in root length, diameter top length, fresh and dry weights of top and root as compared to seed sowing plants, transplanting sugar beet with potassium humate treatments had the best results to modify physiological parameters in favor to plant growth and productivity. This was obviously by increasing, stomatal conductance, transpiration rate, total sugar and K/Na ratio, whereas proline content was decreased. Finally, cultivation sugar beet by transplanting with soil drench by potassium humate at rate of 8 g/L^{-1} could be able to cope with deleterious effect of soil salinity.

Key words: Salinity, Transplanting, Adaptation, Osmoregulation, Sugar beet, Growth, Yield.

Introduction

Salinity is the major environmental stress factor limiting plant growth and productivity in arid and semiarid regions (Parida and Das, 2005). Marschner (1995) reported three physiological mechanisms by which plant suffer from salinity stress, a) lower water potential of the root medium; b) toxic effects of Na^+ and Cl^- and c) nutrient imbalance by depression in uptake and/or shoot transport. High concentrations of salt impose both osmotic and ionic stresses on the plants which lead to several morphological and physiological changes (Munns and Tester, 2008). Several research strive to overcome salt stress problems and these would have a positive impact on agriculture production.

Sugar beet (*Beta vulgaris* L.) is considered as one of the two important sugar crops worldwide. In 1982, sugar beet has been introduced into Egypt as a new sugar crop and a second source for sugar production after sugar cane to minimize the gap between sugar production and consumption. The balance between sugar production and consumption in Egypt shows already a drastic shortage and is far away from self-sufficiency. This gap reaches -34.8% during year 2015 according to Ministry of Agriculture Statistics. Bridging or overcoming this gap is a real challenge with the vast growing population in Egypt (~1.2 million/Year). This goal can be realized by bringing new lands under cultivation. Egypt has a total cultivated area of 3.4 million hectare. Uncultivated land in Egypt, (deserts) occupy about 96% of the total area. Parts of this desert are million of hectare of coastal sites and salinized farmland. The combination of inappropriate irrigation practices and high evapo-transpiration rates are largely responsible for extending the secondary salinization, that usually results in losses of once productive agricultural land, particularly in arid climates (Munne, 2005).

In this concern, sugar beet is one of the most salt tolerant crops and it could be cultivated mainly in saline soils. But it could be relatively sensitive to salinity during seed germination, emergence and in the seedling stage as compared with later stages of growth (Maas, 1986; Marschner, 1995; Ghoulam and Fares, 2001 and Eisa *et al.,* 2011). Durr and Boiffin (1995) reported that early season

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growth (the first 10 weeks) is critical to stand establishment in sugar beet. In sugar beet, the effects of salinity on germination and early growth are a specific effect of ionic toxicity and not principally due to osmotic adjustment (Ghoulam and Fares, 2001). However, sugar beet crop is tolerant to salinity after stand establishment stage. The mechanisms of salt tolerance are depended mainly on its ability to adjust root osmotic potential whereas, soluble sugars concentration in root play the main role for adjusting root osmotic potential (Lindhauer *et al*., 1990 and Eisa and Ali, 2005). Disseminating this diversity toward improving stand establishment is a long term goal, and may help to reclaim the productivity of saline soils.

In Egypt, millions of feddans are suffered from salinity problem; the majority of salt-affected soils are located in northern Nile delta along with the Mediterranean coast, Sahl El-Tina area and some oasis like Fayoum.

One of these approaches is seed treatment and seedlings transplanting. Transplanting of seedling have been widely used to reduce the seedling emergence time, synchronize emergence, improve emergence rate, and better seedling stand in many crops. (Basra *et al.,* 2005). Transplanting is a practice commonly used with small seeded plants, particularly those which are slow or difficult to germinate or require special germination conditions. Among many advantages of transplanting, adjusting plant stand per unit area and raising number of the harvestable plants are of considerable merits. Transplanting is an easy, low cost and low risk technique used to overcome agricultural problems (Iqbal and Ashraf 2005). Seedling is a controlled hydration technique in which, before the actual germination take place (Farooq *et al.,* 2006), and that allows metabolic activities to proceed before radical protrusion as a results of stress conditions (Sirritepe *et al.,* 2003).

However, the common method of beet cultivation worldwide and also, in Egypt is by seeds sowing under saline marginal land at Salh El-Tina area, North Sinai, Egypt.

In view of the above mentioned facts, the present study was undertaken to investigate the effect of transplanting vs direct seed sowing with application of potassium humate solution and silicon organic substances on some growth, physiological responses and ultimately yield production of sugar beet.

Materials and Methods

Two field experiments were carried out at Experimental Station of Desert Research Center (DRC), Sahl El-Tina region, North Sinai, Egypt , during 2013-2014 & 2014-2015 growth seasons on sugar beet (*Beta vulgaris* L.) ssp. Farida which obtained from Sugar Crops Research Institute, Agricultural Research Center (ARC).

Cultivation and experimental design:

Two cultivation methods were used:

1- *Sowing Seed:* Where seeds were directly sown on 15th August for the first and second season, respectively.
2- *Transplanting:* Where sugar beet seeds were sown on 15th August in nursery (greenhouse) for the first and second season, respectively. Using foam trays having 209 holes filled with a growing media. The growing media was prepared by mixing the following materials (150 liters peatmoss, 50 kg vermiculite, 250 g ammonium phosphate, 200 g ammonium nitrate, 150 g potassium sulfate, 50 g micro nutrients mixture (Tradecorp A-Z), 50 cm^3 fungicide (Maxium) and 2 kg Calcium Carbonate). Foam try was kept in green house. After 45 days from planting date, each individual foam pot sack contain one plant, was separated and transplanted into the field.

Soil drench:

Five treatments were applied as soil additives:

Potassium humate (PH) (4 & 8 g/L), Potassium silicate (PS) (4 & 8 g/L) and control. Each plant received 10ml/L started 60 days after sowing and repeated six time with 15 days interval.

The experiment included 10 treatments, which were the combination of five soil drench x two cultivation methods. Treatments were arranged in a split plot design with three replicates. Where cultivation methods were arranged in the main plots, soil drench were allocated randomly in the sub plots. Each plot was 12 m^2 and rows were spaced 0.60 m apart. Plants were thinned to 5 plants per meter of a row.

Soil preparation:

Cattle organic manure and calcium super phosphate fertilizers were added during soil preparation at rates of 20 m^2 and 31 kg P_2O_5 per feddan, respectively. Nitrogen was added at rate of 60 Kg N/fed. as ammonium nitrate (33.5% N). The amount of N fertilizer was split into 2 doses and added after 60 and 110 days from sowing, respectively. Potassium sulfate (48% K_2O) was added before the first irrigation at the rate of 100 kg/fed.

Soil salinity was determined at two different depths 0 -30 and 30- 60 cm. The mean values was (11.5 dsm^{-1})**.** The irrigation process carried out using Canal El-Salam. The chemical analysis of water and soil samples were carried out according to Jackson (1958) and Chapman and Pratt (1982).

Measurements:

Two samples of plants at 90 days from sowing and at harvesting (180 days from planting) were randomly taken from each plot and separated into roots and tops to determine the following characters;

Physiological parameters:

Stomatal conductance and Transpiration rate $mmolm^{-2}s^{-1}$ was determined by (Porometer machine model LI-COR., USA) in full expanded fourth leave from the top of the plant.

Chemical analysis:

- Both plant parts; (top & root) were extracted 2.5 gm plant fresh material with 50 ml boiled ethanol.

- Reducing sugars, Non-reducing and total sugars concentration:

In ethanolic extract, the reducing, non-reducing, and total sugars in the root plant were determined by phosphor-molybdic acid method according to A.O.A.C. (1975), and the absorbance was determined at 640 nm using the spectrophotometer (UNICO UV-2000). The reducing, non-reducing, and total sugar concentrations were calculated as mg/g fresh weight.

-Determination of free proline:

Free proline concentration was measured colorimetrically in the extract of fresh root according to Bates *et al*. (1973).

- Determination of sodium and potassium:

Sodium, potassium were determined photometrically in the acid digested samples by using flame photometer (Perkin Elemer model-149). according to Brown *et al.* (1987).

Statistical Analysis:

Data were subjected to statistical analysis according to Steel and Torrie (1960). L.S.D at 0.05 level was used to detect significant differences.

Results and Discussion

Growth traits:

Effect of cultivation method:

Data presented in Table (1) showed the effect of cultivation method on top length, root length, root diameter, fresh and dry weights in both top and root/plant of sugar beet plant at 90 days after sowing (DAS). Data showed that all growth characters significantly increased with transplanting as compared with direct seed sowing.

Transplanting of sugar beet increased top length, leaves fresh and dry weights/plant as well as root length, root diameter, root fresh and dry weight/plant by about 13, 26, 18, 19, 20, 23 and 10%, respectively, than direct seed sowing.

Table 1: Effect of cultivation method on growth traits of sugar beet at 90 days after sowing (combined data of two seasons).

Cultivation method	Leaves			Root			
	Top length (cm)	Fresh and dry weights/plant (g)		Root length (cm)	Root diameter (cm)	Fresh and dry weights/plant (g)	
		Fresh	Dry			Fresh	Dry
Direct seed sowing	41.48	411.56	102.07	30.63	19.80	486.87	107.03
Transplanting	47.10	519.10	119.97	36.32	23.84	600.21	118.14
L.S.D. at 0.05	2.51	13.14	4.24	2.69	1.49	32.66	3.47

Effect of Potassium treatments:

Regarding, the differences between all potassium treatments on growth traits of sugar beet plant, Table (2) showed that potassium humate (PH) at rate of 8g/L treatment recorded the highest significant mean values of top length, leaves fresh and dry weights/plant as well as root length, root diameter, root fresh and dry weight/plant which reached percentage 15, 34, 11, 21, 30, 36 and 3% respectively. Meanwhile, potassium silicate (PS) at rate of 8g/L recorded the second order for top length, leaves fresh weights/plant. In contrast potassium humate (PH) (4g/L) was better than potassium silicate (PS) (4g/L) to increase root fresh and dry weights/plant at 90 days after sowing.

Table 2: Effect of potassium treatments on growth traits of sugar beet at 90 days after sowing (combined data of two seasons).

Potassium treatments	Leaves			Root			
	Top length (cm)	Fresh and dry weights/plant (g)		Root length (cm)	Root diameter (cm)	Fresh and dry weights/plant (g)	
		Fresh	Dry			Fresh	Dry
Control	41.67	385.23	105.75	31.03	19.06	434.49	111.89
PH (4g/L)	43.86	482.38	111.06	33.17	21.98	518.09	111.81
PH (8g/L)	48.11	519.59	117.97	36.56	24.87	591.85	115.28
PS (4g/L)	43.56	451.31	109.50	32.08	20.45	486.96	110.56
PS (8g/L)	45.25	488.16	114.56	34.53	22.75	561.33	109.36
L.S.D. at 0.05	2.17	13.15	6.50	1.43	1.26	16.94	2.57

Effect of interaction:

The interaction between cultivation methods and potassium treatments had significant effects on all growth traits as shown in Table (3). Generally, transplanting combined with potassium humate (PH) at 8 g/L treatments achieved the highest significant mean values for top length(cm), fresh and dry weights/plant (g) of sugar beet plant the percentage of increments reached 5, 11 and 4% for top length, fresh and dry weight, respectively, whereas of increments reached 5, 9, 10 and 5% for root length, root diameter, root fresh and dry weight, respectively.

Yield and yield components:

Effect of cultivation method:

Significant increases in yield and its components for leaves and root/plant at harvesting stage were recorded by transplanting as compared with direct seed sowing (Table 4). Also, transplanting was found to be supperior than direct seed sowing for increasing top length, leaves fresh and dry yield of plant, fresh yield/fed., root length, root diameter, root fresh and dry yield of plant as well as fresh yield ton/fed. The percentages of increments of leaves fresh yield/fed. and root fresh yield/fed recorded 34 and 9%, respectively.

Table 3: Effect of interaction between cultivation method and potassium treatments on growth traits of sugar beet at 90 days after sowing (combined data of two seasons).

Treatments		Leaves			Root			
		Top length (cm)	Fresh and dry weights/plant (g)		Root length (cm)	Root diameter (cm)	Fresh and dry weights/plant (g)	
			Fresh	Dry			Fresh	Dry
Direct seed sowing	Control	46.25	447.45	108.28	33.40	22.25	504.10	110.03
	PH (4g/L)	46.83	472.28	109.93	33.88	22.93	525.40	109.03
	PH (8g/L)	48.13	490.53	111.88	34.78	23.85	548.25	108.68
	PS (4g/L)	47.10	475.28	110.45	34.10	23.05	532.15	107.88
	PS (8g/L)	48.13	490.50	111.88	34.75	23.85	548.25	108.68
Transplanting	Control	46.48	452.08	108.94	33.65	22.38	508.85	110.81
	PH (4g/L)	47.03	478.08	110.28	34.03	23.08	529.00	109.33
	PH (8g/L)	48.73	496.98	112.48	35.03	24.35	554.00	112.33
	PS (4g/L)	46.65	466.48	109.60	33.70	22.75	521.80	108.73
	PS (8g/L)	47.53	484.05	111.28	34.50	23.35	542.50	107.03
L.S.D. at 0.05		1.03	5.05	5.10	0.06	0.56	5.28	1.07

Table 4: Effect of cultivation method on yield and yield components of sugar beet at 180 days after sowing (combined data of two seasons).

Cultivation method	Leaves				Root				
	Top length (cm)	Fresh and dry weights/plant (g)		Fresh yield (ton./fed)	Root length (cm)	Root diameter (cm)	Fresh and dry weights/plant (g)		Fresh yield (ton./fed)
		Fresh	Dry				Fresh	Dry	
Direct seed sowing	40.89	516.86	137.67	8.79	38.79	23.33	1660.06	483.08	28.79
Transplanting	44.94	567.59	145.54	11.76	44.80	29.65	2096.87	513.27	31.32
L.S.D. at 0.05	1.53	38.54	15.35	2.25	3.33	2.68	110.48	29.47	1.52

Effect of potassium treatments:

In regard to the effect of plant treatments with potassium humate (PH) (4, 8 g/L) and potassium silicate (PS) (4, 8 g/L) on top length, leaves fresh and dry yield of plant, fresh yield/fed., root length, root diameter, root fresh and dry yields of plant as well as fresh yield ton/fed. data in Table (5) showed that potassium humate (PH) (8g/L) recorded the highest significant mean values for top length, leaves fresh and dry yield/plant, fresh yields/fed., root length, root diameter, root fresh and dry yields/plant as well as fresh yield ton/fed. The percentages of increments reached 22, 53, 71, 15, 24, 20, 62, 51 and 8.6%, respectively, as compared with control treatment potassium silicate (PS) (8g/L) ranked in a second order after potassium humate (PH) at ($8g/L^{1-}$).

Table 5: Effect of potassium treatments on yield and yield components of sugar beet at 180 days after sowing (combined data of two seasons).

Potassium treatments	Leaves				Root				
	Top length (cm)	Fresh and dry weights/plant (g)		Fresh yield (ton./fed)	Root length (cm)	Root diameter (cm)	Fresh and dry weights/plant (g)		Fresh yield (ton./fed)
		Fresh	Dry				Fresh	Dry	
Control	36.92	434.82	116.58	10.84	37.00	23.78	1415.81	393.06	22.85
PH (4g/L)	40.84	526.25	148.29	12.91	42.10	26.96	1925.63	507.57	29.74
PH (8g/L)	45.14	665.71	199.49	16.46	46.14	28.59	2301.66	595.25	36.60
PS (4g/L)	39.56	491.18	140.82	12.32	39.45	25.45	1756.39	442.35	27.72
PS (8g/L)	42.11	592.94	164.63	15.10	44.29	27.67	1992.86	552.64	33.38
L.S.D. at 0.05	2.14	15.61	8.68	1.45	2.56	1.44	75.34	22.81	1.65

Effect of interaction:

The combined effects of cultivation method and potassium treatments on top length, leaves fresh and dry yields of plant, fresh yield/fed., root length, root diameter, root fresh and dry yields of plant as well as fresh yield ton/fed of sugar beet plant under saline conditions are shown in Table (6). Generally, the highest mean values of yield and its components were obtained by potassium humate (PH) (8g/L) application combined with transplanting. However potassium silicate (PS) (8g/L) as plant treatment recorded the second order for yield and its components of sugar beet plant under saline conditions.

Table 6: Effect of interaction between cultivation method and potassium treatments on yield and yield components of sugar beet at 180 days after sowing (combined data of two seasons).

Treatments		Leaves				Root				
		Top length (cm)	Fresh and dry weights/plant (g)		Fresh yield (ton./ fed.)	Root length (cm)	Root diameter (cm)	Fresh and dry weights/plant (g)		Fresh yield (ton./fed.)
			Fresh	Dry				Fresh	Dry	
Direct seed sowing	Control	40.38	545.40	148.20	14.13	42.73	24.78	1765.58	505.85	27.78
	PH (4g/L)	42.03	580.30	162.55	15.08	43.68	26.18	1986.18	542.98	30.53
	PH (8g/L)	43.15	630.75	178.15	16.60	45.28	27.38	2093.33	585.95	33.08
	PS (4g/L)	42.20	594.43	166.40	15.63	44.18	26.48	1988.10	552.85	31.40
	PS (8g/L)	43.15	630.78	178.15	16.60	45.28	27.38	2093.30	585.95	33.05
Transplanting	Control	40.49	548.75	148.80	14.26	43.01	25.04	1787.69	507.73	27.84
	PH (4g/L)	42.28	588.50	164.10	15.23	44.03	26.58	2018.28	557.08	30.68
	PH (8g/L)	43.65	644.80	184.50	16.90	45.53	27.58	2164.48	595.05	33.68
	PS (4g/L)	41.75	572.13	161.00	14.93	43.33	25.78	1954.05	528.85	30.35
	PS (8g/L)	42.65	616.73	171.80	16.30	45.03	27.18	2022.15	576.85	32.45
L.S.D. at 0.05		0.11	24.75	7.38	1.06	1.12	1.22	27.21	5.68	1.58

Physiological traits:

Effect of cultivation method:

Stomatal conductance, transpiration rate Table (7). Were shown in a significant increase was realized with transplanting.

The average values of proline concentration measured in leaves of sugar beet plants showed significant differences between direct seed sowing and transplanting. A markedly decrease in proline concentration by transplanting was detected.

Transplanting treatment significantly increased both of reducing and non-reducing sugars compared to direct seed sowing treatment.

Table 7: Effect of cultivation method on stomatal conductance, transpiration rate, proline, total sugars, reducing sugars, non-reducing sugars and K/Na in sugar beet at 90 days after sowing (combined data of two seasons).

Cultivation method	Stomatal Conductance (mmol m^{-2} s^{-1})	Transpiration Rate (mmol m^{-2} s^{-1})	Proline µ mol/g	Total sugars (g/d.w.)	Reducing sugars (g/d.w.)	Non-reducing sugars (g/d.w.)	K/Na (mg/g d.w.)
Direct seed sowing	19.11	17.77	6.25	12.05	6.54	5.52	3.2
Transplanting	19.92	19.05	5.53	12.63	6.20	6.43	3.9
LSD at 0.05	0.09	0.33	0.06	0.23	0.19	0.18	

Effect of Potassium treatments:

Regarding, the effect of potassium treatments on stomatal conductanc and transpiration rate, data in Table (8) revealed that PH at rate of 8 g/L was the best treatment to increase, stomatal conductancas and transpiration rate as compared to other treatments.

A markedly decreased in proline concentration was observed by potassium treatments reaching to minimum concentration with potassium humate at rate of 8 g/L.

Data in Table (8) indicated that total soluble sugar was significantly increased by using silicon (8 g/L) as compared with other treatments. Meanwhile, plant treatment with humic (4 g/L) achieved the highest mean values of reducing sugar. On the other hand, non-reducing sugars was significantly reduced by all plant treatments as compared with the control plant.

Table 8: Effect of potassium treatments on stomatal conductance, transpiration rate, proline, total sugars, reducing sugars, non-reducing sugars and K/Na in sugar beet at 90 days after sowing (combined data of two seasons).

Potassium treatments	Stomatal Conductance (mmol m^{-2} s^{-1})	Transpiration Rate (mmol m^{-2} s^{-1})	Proline µ mol/g	Total sugars (g/d.w.)	Reducing sugars (g/d.w.)	Non-reducing sugars (g/d.w.)	K/Na (mg/g d.w.)
Control	17.87	16.63	7.22	11.10	5.68	5.42	3.3
PH (4g/L)	19.13	17.79	5.89	12.02	6.61	5.41	5.42
PH (8g/L)	20.81	19.94	4.53	13.15	6.61	6.53	7.41
PS (4g/L)	19.52	18.38	6.49	12.19	6.27	5.92	4.2
PS (8g/L)	20.25	19.30	5.32	13.26	6.68	6.58	5.1
LSD at 0.05	0.10	0.11	0.28	0.44	0.45	0.54	

Effect of interaction:

Concerning, the interaction between cultivation methods and soil drench of potassium treatments, the data presented in Table (9) revealed that stomatal conductance, transpiration rate recorded the highest significant value under both cultivation methods with soil drench treatments as compared with control.

Table 9: Effect of interaction between cultivation methods and potassium treatments on on stomatal conductance, transpiration rate, proline, total sugars, reducing sugars, non-reducing sugars in sugar beet at 90 days after sowing (combined data of two seasons).

Treatments		Stomatal Conductance (mmol m^{-2} s^{-1})	Transpiration Rate (mmol m^{-2} s^{-1})	Proline µ mol/g	Total sugars (g/d.w.)	Reducing sugars (g/d.w.)	Non-reducing sugars (g/d.w.)
Direct seed sowing	Control	19.55	18.20	6.48	12.15	6.23	5.93
	PH (4g/L)	20.05	18.70	6.08	12.45	6.48	6.03
	PH (8g/L)	20.35	19.15	5.73	12.85	6.53	6.33
	PS (4g/L)	20.15	18.93	6.03	12.68	6.48	6.23
	PS (8g/L)	20.38	19.13	5.70	12.85	6.53	6.33
Transplanting	Control	19.58	18.25	6.44	12.18	6.21	5.96
	PH (4g/L)	20.05	18.60	5.98	12.45	6.53	5.93
	PH (8g/L)	20.45	19.20	5.58	12.85	6.53	6.33
	PS (4g/L)	20.05	18.78	6.18	12.48	6.43	6.13
	PS (8g/L)	20.28	19.08	5.85	12.85	6.53	6.33
LSD at 0.05		0.02	0.16	0.24	0.46	0.38	0.51

Potassium humate (PH) 8g/L as a soil drench with the transplanting method recorded the highest significant mean values for stomatal conductance and transpiration rate. Generally all interaction treatments were better than control for increasing stomatal conductance, transpiration rate. Soil drench and cultivation methods interaction significantly increased both of reducing and non-reducing sugars compared with the control. The highest concentration of reducing and non-reducing sugar was observed with transplanting method and a soil drench by potassium humate 8g/L .The average values of proline concentration measured in leaves of sugar beet plants showed significant decrease in both cultivation methods and potassium treatments.

Discussion

Transplanting of sugar beet plants was used to achieve the following benefits, firstly it allow seed germination and seedling establishment without exposing to soil salinity. Therefore, it could be obtained uniform healthy seedling. So, there is no need to consume more seeds to compensate absent seedling in arable land. Secondly, many farmer prefer to keep the land free from summer crops for achieving early yield of sugar beet in the case of transplanting, the farmer had more time (45 days) to harvest summer crops and prepare the land for sugar beet cultivation. The obtained results showed that transplanting surpassed seed sowing in all growth parameters (Table 1).

This effect is due to avoid salt stress during seed germination and seedling growth, whereas, by direct seed sowing, salinity stress reduce germination rate and seedling growth, however the early developed stage of sugar beet was more sensitive to salinity than late one. Sugar beet became more salt tolerant as more as root and leaves developed this leaves allow more sugar accumulation in root system to cope with high salinity in soil as shown in Table (8).

The remediation of salinity stress in sugar beet could be achieved by several mechanism, it could be able to substitute K^+ with Na for consistence stability of osmotic potential this was obviously by keeping higher transpiration rate and stomatal conductance even in untreated plants.

Gaseous exchange measurement in term, of stomatal conductance, transpiration rate, the ratio of internal to external CO_2 concentration is consider crucial physiological parameter to demine internal water status in plant either under stress or unstressed conditions. Eisa *et al.,* (2012) reported that salt induced an increase in stomatal resistance correlated with substantial reduction in the transpiration rate. Reduction in the transpiration rate was much greater than that of photosynthetic rate leading to improve water use efficiency. However as second mechanism is rapid synthase osmolyte solutes included proline and sugars. This was clear from present results (Tables 7 and 8). Additional potassium either in form of humate or silicate increased K/Na ratio and decreased ion toxicity with increasing carbon assimilation.

The present data in Table (2) indicated that application of potassium humate, or silicate had positive effect on growth parameters of sugar beet plant, as compared to control.

The present results was found to be in accordance, with Zapata *et al.* (2004). The salt tolerance mechanisms of sugar beet plants have been studied by many investigators such as Lindhauer *et al.* (1990); Marschner (1995); Koyro and Huchzermeyer (1997) and Eisa and Ali (2005). They summarized that sugar beet has an includer mechanism to achieve salt tolerant, whereas the plant has the ability to uptake salty water and immediately transplanted into shoot. This mechanism facilitates osmotic adjustment but can lead to toxicity and/or nutritional imbalance. However, the main salt tolerance mechanism for sugar beet plant is depended mainly on its ability to decrease or regulate root osmotic potential by accumulating of soluble sugars in root which play the main role for adjusting root osmotic potential. Therefore, sugar beet is sensitive to salt during its germination and early growth stage, where there is not enough photosynthesis activity to build more sugar for adjusting root osmotic potential. This was obviously in direct seed sowing method comparing to transplanting one, in the same regards, salt induced inhibition of seed germination and seedling growth (fresh root and shoot weights) could be attributed to osmotic stress or to specific ion toxicity. These results are in line with Huang and Redmann (1995); Jeannette *et al.* (2002) and Jamil *et al.* (2006).

Accordingly, transplanting of beet plant may be the way to avoid the harmful effect of salinity on sensitive growth stage which finally reflects up on yield. In sugar beet as well as in other crops, agronomic characteristics such as yield and some chemical properties are most commonly used criteria for evaluating salinity tolerance of the crop. This is probably due to their ease of measurement and the fact that yield under saline conditions, is what ultimately matters and more relevant criteria for improving salt tolerance in crop.

Our results are in agreement with those obtained by Eneji *et al.,* (2008) who found that 1000 mg kg^{-1} potassium silicate (K_2SiO_3) application to the soil under transplanting "produced the greatest biomass yield responses across species," as compared to calcium silicate ($CaSiO_3$) or silica gel. According to Gunes *et al.* (2008), In this respects, Ihsanullah (2014) stated that humic acid (HA) significantly ($p<0.05$) increased plant growth (i.e., plant height), green and dry matter yield.

The previous response can be explained by the role of total sugars accumulated in root in case of transplanting, consequently that lead to uptake salty water which contain a high level of Na. However, the uptake Na rapidly translocated into the shoot and there occurred a replacement of K^+ by Na^+ in various metabolic functions. The accumulation of Na in leaves parallel with decreasing K content, may give us an important explanation for the reflection of salt stress on yield. Here it might be suggested that, the value of leaves K/Na ratio over one reflected unsaturated leaves from Na and this was concomitant with neglect harmful effect on plant due to toxic or imbalance effects. On the other words, if the leaves K/Na value was over one, that might be an indication for an active includer mechanism and the leaves in this case could uptake more Na.

Proline, as an amino acid, is well known to accumulate in a wide variety of organisms ranging from bacteria to higher plants on exposure to abiotic stress (Ahmad and Jhon, 2005; Ahmad *et al.,* 2006 and Ahmad *et al.,* 2008). Proline being a cytosolic osmoticum and a scavenger of hydroxyl radicals can stabilize the structure and function of macromolecules such as DNA, protein, and also of the membranes (Kishor *et al.,* 2005). Proline, sharing this property with other compounds collectively referred to as compatible solutes, are accumulated by a wide range of organisms to adjust cellular osmolarity (Yancey, 2005). The increase in proline content can be helpful in maintaining osmoticum under various environmental stresses, so decreasing proline content by transplanting method and/or by potassium application proved that sugar beet plant was not under stress conditions.

However Zaki *et al.,* (2012) and Amer *et al.,* (2004) found that application of potassium fertilizer with rate of 90 kg of K_2O/fed. significantly increased nitrogen, phosphorus and potassium percentage in the beet root.

In the same concern, Salami and Saadat (2013) mentioned that sodium content had been decreased with the use of potassium fertilization with the rate of 48 kg K_2O/fed. In addition, Nitrogen, potassium, phosphorus, iron and magnesium contents of foliage were higher than in roots which could be related to the effect of potassium fertilizer on improving photosynthesis and maintaining the normal balance between carbohydrates and proteins.

Also, mitigation adverse effect of salt stress could be achieved by pre-sowing sugar beet seeds with potassium humate (Eisa *et al., 2012*). This reveal that potassium humate could be applied by different way to counteract the excess of Na^+ ion and consequently diminish for some extent ion toxicity.

Conclusion

It could be concluded that transplanting of sugar beet with application of potassium treatments as soil drench achieved higher growth and yield under saline soil conditions at Sahl El-Tina area, North Sinai, Egypt.

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