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MUTUAL EFFECT AMONG COMPOST AND FOLIAR SPRAYING WITH ZINC AND BORON ON SUGAR BEET (*Beta vulgaris l.)* GROWN ON SALINE SANDY LOAM SOIL

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ABSTRACT

Two field experiments were conducted at the village (7) in Gelbana, North Sinai Governorate, Egypt during two successive winter seasons of 2013/2014 and 2014/2015 to study the response of sugar beet (Mirodor) grown on saline sandy loam soil to study the interaction effect of compost, (CO) amendment and foliar spraying with micronutrients (Zn and B) solely or in combinations on some growth parameters, productivity and nutrients content in sugar beet roots. The obtained results reveal that CO and foliar application with Zn and B enhanced the growth and yield productivity of sugar beet roots as well as nutrient contents. Available N, P, K, Fe, Mn, Zn and B contents were increased due to the above mentioned treatments. On the other hand, the electrical conductivity (EC dSm^{-1}) and soil pH values decreased due to these treatments. Foliar spray with micronutrients in combination with CO substantially elevated these parameters N, P, K, Fe, Mn, Zn and B contents in roots were significantly increased by application of the treatments. The highest response of productivity and nutrients content in root were achieved by application of CO in combination with foliar spray of Zn + B followed by foliar spray of Zn + B in both seasons . Highest values of yield, yield components, nutrient contents and sucrose percent as well as sugar yield were obtained due to the application of compost at rate of 5 Mg $fed.^{-1}$ + foliar spray with Zn + B in both seasons.

Keywords: Foliar spray, Compost, Micronutrients (Zn and B), Sugar beet, Sandy loam soil, Saline soil

INTRODUCTION

El-Tina Plain (about 50,000 feddans) is located at the northwestern part of Sinai Peninsula, Egypt, between longitudes 32º 20' 35" and 32º 33' 10" east and latitudes 30º 57' 25" and 31º 04' 28" north, approximately 174 km^2. It is situated under arid conditions; the annual rainfall ranges from 33.3 mm to 70.2 mm and occurs over a short period (from October to March). Air temperature ranges from 7.6 to 23.4 °C and between 16.4 and 35.7 °C in winter and summer, respectively (Aly 2005).

Sugar beet (*Beta vulgaris* L.) is the second crop for sugar production in Egypt after sugar cane. Recently, sugar beet crop has been favorable importance in local crop rotation as a winter crop not only in fertile soils, but also in poor, saline, alkaline and calcareous soils. Moreover, it could be economically grown in newly reclaimed soils. Nowadays, manure is being extensively used as a robust tool to maximize crop productivity. Deficiency of soil nutrients such as nitrogen, phosphorus, potassium, zinc and boron has been identified as the major constraints in beet crop production and, based on plant needs, should be added to the soil, Ali (2015).

Soil salinity is adversely affecting physiological and metabolic processes, finally diminishing growth and yield (Ashraf and Harris, 2004). Excessive salts injure plants by disturbing the uptake of water into roots and interfering with the uptake of competitive nutrients (David, 2007). 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 (Khan *et al.,* 1995).

Micronutrient deficiency is widespread in plants, animal and humans, especially in many arid countries, due to high pH, low organic matter, drought, high bicarbonate contents in irrigation water and imbalanced application of fertilizers (Malakouti, 2008). Micronutrients are required in small amounts and they affect directly or indirectly photosynthesis, vital processes in plant such as respiration, protein synthesis, reproduction phase. In this connection, many investigators in Egypt reported positive response of different field crops to micronutrient fertilization. (Seadh, *et al.* 2009, Potarzycki and Grzebisz, 2009, Zeidan, *et al.* 2010, Kanwal, *et al.* 2010, Salem and El-Gizawy, 2012, Siam, *et al.* 2012).

Boron is unique, not only in its chemical properties, but also in its roles in biology. Since boron discovery as essential plant nutrient, the importance of B element as an agricultural chemical has grown very rapidly and its availability in soil and irrigation water is an important determinant of agricultural production. Boron deficiency is the most common and widespread micronutrient deficiency problem, which impairs plant growth and reduces yield. Normal healthy plant growth requires a continuous supply of B, once it is taken up and used in the plant; it is not translocate from old to new tissue. That is why, deficiency symptoms starts with the youngest growing tissues. Therefore, adequate B supply is necessary for obtaining high yields and good quality y of agriculture crops (Saleem *et al.*, 2011). Boron (B) is one of the sixteen essential nutrient elements, required for proper growth and yield of crop plants, Tariq and Mott (2006). It plays important role in water relations, cell wall formation; cations and anions absorption, pollen viability and metabolism of N, P, carbohydrates and fats in the plant (Oyinlola, 2007). Jaszczolt (1998) found that the foliar spray of boron was significant increase effect on root fresh weight, sucrose (%), root and top yields with increasing boron levels. Kirstek et al (2006) suggested that the effect of boron element (1.0 kg B/ha) was increase sugar beet root yield and quality compared with control. Hellal et al (2009) reported that the boron foliar application led to significant increase in both concentration and uptake of K, Fe, Mn, Zn in sugar beet.

Zinc plays an important role as a metal component of enzymes (superoxide dismutase, carbonic anhydrase and RNA polymerase) or as a functional, structural or regular cofactor of a large number of enzymes, (Rmheld and Marchner, 2006). Zinc is an essential component or activator for many enzymes involved in photosynthesis and hence has an important role in early seedling vigor. Zinc plays an important role in the production of biomass (15) and chlorophyll production (16). Mekki (2014) indicated that the foliar application with 400 ppm Zn led to increased root length and diameter as well as fresh root and top yield weight.

Compost is a low cost as organic fertilizers and soil amendment (Francis and Daniel, 2004). When applied to soils, it positively affects the structure, porosity, water holding capacity, nutrient contents and organic matter all of which improve plant growth and crop yield (Rajaa and Saadi, 2011 and Gosling *et al.*, 2006).

The present study was initiated to evaluate the effect of compost addition with the foliar application of Zn or B and their combination on sugar beet yield, yield components, chemical composition, nutrient content as well as nutrient available forms in soil after harvest under saline soil conditions.

The current study aims at assessing compost application through the soil and foliar spray with micronutrients solely or in combinations on improving sugar beet yield and its components as well as root quality and its nutrients content.

MATERIALS AND METHODS

Two field experiments were carried out during the two successive winter seasons of 2013/2014 and 2014/2015 at Gelbana village No. (7), North Sinai Governorate, Egypt to study the response of sugar beet (*Beta vulgaris* cv. Mirodor) to application of compost, (CO) and foliar spraying with micronutrients (Zn and B) solely or in combinations on sugar beet yield, yield components, chemical composition, nutrient content as well as nutrient available forms in soil after harvest under saline soil conditions. A representative soil sample (0 – 30 cm) was taken before planting to determine some physical, chemical and nutritional properties (Table 1).

Table 1. Physical and chemical properties of the investigated soil.

Property	Value	Property	Value
Particle size distribution		EC (dSm^{-1}) in soil paste extract	13.83
Clay %	14.12	Soluble ions (mmolc L^{-1})	
Silt %	7.71	Na^{+}	109.21
Fine sand %	69.15	K^{+}	0.91
Coarse sand %	9.02	Ca^{++}	9.71
Textural class	Sandy Loam	Mg^{++}	18.49
pH [Soil suspension 1:2.5]	8.06	Cl^{-}	98.71
Organic matter (g kg^{-1})	6.81	HCO_3^{-}	10.29
$CaCO_3$ (g kg^{-1})	89.01	$SO_4^{=}$	29.30

Available macro and micronutrients (mg kg^{-1} soil) *						
N	**P**	**K**	**Fe**	**Mn**	**Zn**	**B**
33.9	3.79	192	2.84	1.17	0.85	0.10

*** (1) Extractants of available nutrients: NH_4HCO_3-DTPA (P, K, Fe, Mn and Zn), KCl (N)**
(2) Texture according to the international soil texture triangle.

Compost manure was prepared (Nasef *et al.,* 2009) using 5 Mg (megagram; 1 Mg = 10^6 g)= ton of some crop residues (rice straw, maize stover and faba bean straw), air dried and piled into 5 – 10 layers, each about 50-cm thick, An amount of 300 kg/weight of farmyard manure was added to each pile to enhance microorganism activity. Piles were moistened with a sufficient quantity of water (about 60%). Every 21 days the piles were turned over until well decomposed. After 63 days the compost was well decomposed and ready for use. The CO manure was mixed thoroughly with the soil one month before sowing at rate of 5 Mg fed.$^{-1}$. The final product was chemically analyzed according to Brunner and Wasmer (1978).

Table 2. Chemical properties of compost.

Moisture content (%)	EC dS m^{-1} 1:10	pH 1:2.5	C/N ratio	Total macro-nutrients			Total micro- nutrients			
				N	P	K	Fe	Mn	Zn	B
				(g kg^{-1})			(mg kg^{-1})			
25	3.12	7.76	20.12	18.52	8.81	19.01	33.1	72.5	29.8	1.02

Phosphorus fertilizer was added to all plots before sowing at a rate of 30 kg P_2O_5 fed.$^{-1}$ as superphosphate (15.5 % P_2O_5). Nitrogen fertilizer was added to all plots at a rate of 100 kg N fed.$^{-1}$ in the form of urea (46% N) at three equal splits, immediately after thinning (21 days after sowing, DAS), 42 and 65 DAS. Potassium sulphate (48 % K_2O) was applied as soil application at a rate of 100 kg K_2O fed.$^{-1}$ in two equal split, 21 and 40 days after sowing. All normal agricultural practices recommended for the region were followed.

Plants were sprayed with boron in the form of borax (11% B) at the concentration of 0.13% and zinc in the form of zinc sulphate (23% Zn), at the concentration of 0.5 %. Spray solution rate was 400 L fed.$^{-1}$ applied three times (25 days after seeding, then 20 and 30 days afterwards. A randomized complete blocks design with three replicates, having a plot area 5 X 10 m^2, was used. Each plot consisted of 10 rows 50cm apart, two plant/ hill and 25 cm between hills. Sugar beet seeds (*Beta vulgaris* L.) cv. Mirodor was sown after soil preparation. Seeding was carried on September 12th 2013/2014 and 2014/2015 seasons, respectively. Harvest was done on, 7th and 9th of April 2014 and 2015, respectively. The treatments were as follows:

1) Control. 2) Compost manure, (CO) 3) Zn 4) B
5) CO + Zn. 6) CO + B. 7) Zn + B. 8) CO + Zn + B.

At maturity, two rows of each plot were harvest, air dried, then root yield (Mg fed.$^{-1}$) was recorded. In addition, representative ten plants were taken randomly from each plot to record the following characters. 1) root length 2) root weight plant^{-1}.

Methods of Analysis

Root samples were oven dried at 70^o C and digested using H_2SO_4 and $HClO_4$ mixture to determine nutrient contents. Plant analysis was done according to Chapman and Pratt (1961), and AOAC (1990). Sucrose % was determined using Sacharimeter apparatus according to the method described by Le – Docte (1927), and then the sugar yield was also calculated by multiple root yield (Mg fed^{-1}) X Sucrose %. Soil analysis was done according to Black *et al.,* (1965). Available Mn, Zn and Cu were extracted by DTPA (Lindsay and Norvell, 1978) and determined using inductively Coupled Plasma (ICP) Spectrometer model 400 (Soltampour, 1985). Available B was extracted by hot water and determined by the azomethine – H colorimetric method (Gaines and Mitchell, 1979).

Statistical analysis

Results were statistically analyzed using COSTATC software. The ANOVA test was used to determine significantly ($p \leq 0.01$ or $p \leq 0.05$) treatment effect and Duncan Multiple Range Test was used to determine significantly of the difference between individual means (Duncan, 1955).

RESULTS AND DISCUSSION

Effect of different treatments on soil pH, EC and available nutrients in soil after harvesting.

Soil pH and Soil Salinity (EC_e)

Fig. 1 (a and b) shows an obviously slight response for some soil properties (i.e., pH and EC) to the applied treatments, particularly the treatment of Compost + Zn + B which was superior over the other treatments. The applications of compost solely or in combination with Zn or B caused a noticeable reduction in the values of soil pH and EC_e. These results may be attributed to one or more of the following reasons:

i. Organic compost decomposition tends to accelerate in the presence of microbial media of bio-fertilizer, and in turn produces active organic and inorganic acids that led to decrease soil pH beside to its ability to chelate metal ions (Fe, Mn and Zn). These chelated metal ions are held in available forms for plant and consequently they are found as strategic storehouse in organo-metalic compounds that are more suitable for uptake by plant roots. The decomposed compost acts as slow release fertilizer that can supply the plants with nutritive elements slowly but over a long time and hence it minimizes their possible loses by leaching throughout the studied relatively coarse textured soil. (Mohammed, 2004).

ii. The effective role of microbial activity to reduce soil salinity stress, could be interpreted according to many opinions outlined by Ashmaye *et al.* (2008) who reported that many strains produce several phytohormones(i.e., indole acetic acid and cytokinins) and organic acids. Such products reduce the deleterious effect of Na-salts, and simultaneously improve soil structure, i.e., increase aggregate stability and drainable pores and hence accelerate leaching of soluble salts and soil profile with the drained water.

iii. The released soluble Ca^{2+} partially substitutes exchangeable Na and leads to reduce ESP value and formation of small clay domains. Such clay domains are coated with the released active organic acids, and then form coarse sizes of water stable aggregates which accelerate leaching of a pronounced content of soluble salts and accordingly reduce the ECe value (Ewees and Abdel Hafeez, 2010).

Fig.1 shows that the lowest soil pH and EC_e values *i.e.* 7.95 and 6.58 dSm^{-1} as well as 7.90 and 6.42dSm^{-1} at first season and second season , respectively were achieved due to the treatment compost + Zn + B caused decreases of 1.00 and 37.51 % at first season as well as 1.50% and 28.75% at second season , respectively.

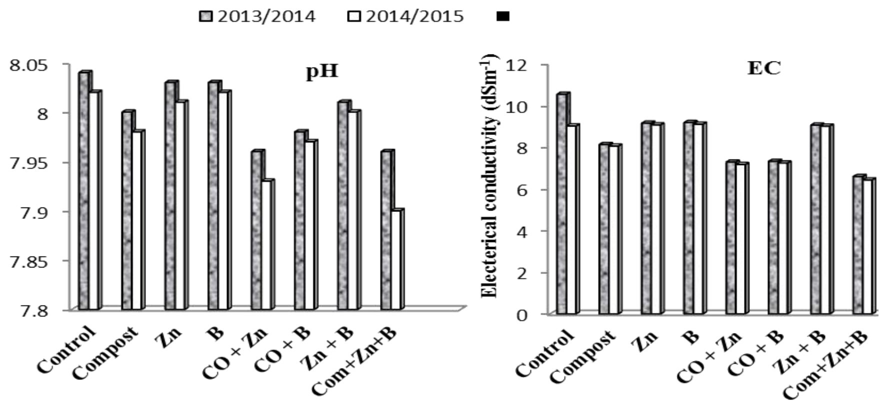

Fig. 1 Soil pH (a) and EC_e (b) after harvest as affected by the investigated treatments

Available macronutrients (N, P and K)

Data presented in Table 3, show the available N, P and K (mg kg^{-1}) as affected by the used treatments and their combinations on the studied soil. Data revealed that available N, P and K increased as affected by the treatments of compost, Zn and B and their combinations. Available N ranged from 37.29 to 46.25 mg kg^{-1} for first season and 37.66 to 47.16 mg kg^{-1} for second season. Available P varied between 3.95 to 4.22 mg kg^{-1} for first season and 3.98 to 4.23 mg kg^{-1} for second season respectively. Available K ranged between 196 to 225 mg kg^{-1} in first season and 198 to 229 mg kg^{-1} in second season. The soil treated with compost + Zn + B gave the highest values of available N, P and K. The positive effect of compost is partially due to a slow release of N from manure, as suggested by Bhandari *et al.* (2002). The P and K fractions added through organic manures upon its decomposition with time may account for the increases in both P and K. (Yadvinder *et al.,* 2004). Also the production of organic and inorganic acids during the degradation of such organic materials (as well as humates) as a result of the microorganisms activities must have contributed to a decrease in soil pH which would reduce K fixation and produce more chelating ions, leading to an increase in available forms of elements in the rhizosphere zone. These results are in agreement with those obtained by Ewees and Abdel Hafeez (2010). The corresponding relative increases were 24.03% and 25.23% in first season and second season for available N, 6.40% and 6.28% in first season and second season for available P and 14.80% and 15.66% in first season and second season for available K. This was found to be obvious due true due to the treatment of compost + Zn + B.

Available micronutrients (Fe, Mn, Zn and B)

As shown in Table (4) the concentrations of Fe, Mn, Zn and B in soil at the end of the experiment increased due to application of compost, Zn and B and their combinations in comparison with the untreated control treatment; however the increases occurred were insignificant except for B which was significant. This fact hold true for the two seasons under study. This may be due to the vital role of compost which contains microorganisms that make these nutrients more available in the soil.

Table 3. Effect of treatments on available macronutrients in soil after harvest during first season and second season .

Treatment	Available Macronutrients (mg kg^{-1})					
	N		P		K	
	first season	second season	first season	second season	first season	second season
Control	37.3 d	37.7 f	3.95	3.98	196	198 b
Compost, (CO)	40.7 e	40.9 e	3.99	4.01	201	205 ab
Zn	40.3 e	40.5 e	4.05	4.09	205	208 ab
B	43.5 d	43.8 d	4.09	4.12	209	213 ab
CO+Zn	44.4 c	45.0 c	4.12	4.16	214	219 ab
CO+B	45.3 b	46.2 b	4.11	4.15	218	222 a
Zn+B	45.5 b	46.9 a	4.16	4.19	220	226 a
CO+Zn+B	46.3 a	47.2 a	4.22	4.23	225	229 a
Grand Mean	42.9	43.5	4.09	4.12	211	215
$LSD_{0.05}$	0.656	0.517	NS	NS	NS	15.63

Table 4. Effect of treatments on available micronutrients in soil after harvest during first season and second season.

Treatment	Available Micronutrients (mg kg^{-1})							
	Fe		Mn		Zn		B	
	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015
Control	2.89	2.91	1.21	1.22	0.88	0.91	0.12 b	0.13 b
Compost, (CO)	2.93	2.94	1.28	1.29	1.02	1.04	0.15 ab	0.17 ab
Zn	2.95	2.97	1.31	1.33	0.98	1.01	0.18 ab	0.21 ab
B	2.97	3.02	1.33	1.35	1.04	1.07	0.21 ab	0.21 ab
CO+Zn	3.04	3.09	1.35	1.36	1.01	1.03	0.23 ab	0.25 ab
CO+B	3.08	3.12	1.39	1.41	1.08	1.11	0.24 ab	0.26 ab
Zn+B	3.11	3.16	1.41	1.42	1.11	1.12	0.27 a	0.28 ab
CO+Zn+B	3.13	3.18	1.45	1.48	1.13	1.15	0.29 a	0.31 a
Grand Mean	3.01	3.05	1.34	1.36	1.03	1.06	0.21	0.23
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	0.093	0.096

In addition, compost may play a vital role for increasing nutrients availability through the processes of chelating, biochemical processes and production of several organic acids during decomposition of compost as reported by Hammad and Abdel Ati (1998).

Also, bacteria cause some micro nutritive elements such as Fe, Mn, Zn and B to release in available forms in soil through break down of organic materials in the soil (Bhande *et al.,* 1997). The highest available Fe, Mn, Zn and B values (3.13, 1.45, 1.13 and 0.29 mg kg^{-1}) in first season and (3.18, 1.48, 1.15 and 0.31 mg kg^{-1}) in second season, respectively were obtained under the treatment of compost + Zn + B.

Growth parameters and yield of sugar betas influnced by tested treatments.

Some growth parameters of sugar beet plants are shown in Table 5. Application of compost, Zn and B solely or in combinations significantly, increased root length and root weight as compared to the untreated (control). This was found true for both the first season and second season. Effect of the fertilizer treatments followed the order of, compost + Zn + B > Zn +B > compost + B > B > Zn > compost + Zn > compost at first season and compost + Zn + B > Zn + B > compost +B > compost + Zn > B > Zn = compost at second season. The highest root length and root weight were recorded in the plants treated with compost + Zn + B which caused increases of about 52.03% and 150% in first season and 48.99% and 142% in second season, respectively. This shows the positive effect of organic matter which would releases the nutrients in available form. Previous studies justified the positive effects of nitrogen application (Abedi *et al.,* 2010 and Daneshmand *et al.,* 2012).

Root yield:

As shown in Table 5, compost application, Zn and B as well as their combinations significantly, increased root yield of sugar beet plants. The treatments followed the following descending order: compost + Zn +B > Zn + B > compost +B > compost + Zn > B > Zn > compost. This trend was found to be true for both seasons. The organic manure treated soil plots became more enriched in the released nutrient, especially the micronutrients, which directly or indirectly in valve in formation of starch, protein and other biological components through their roles in the respiratory and photosynthesis mechanisms as well as in the activity of various enzymes. In addition, the organic manure leads to improve soil physicochemical, hydrological and biological characteristics, which facilitate nutrients uptake by plants and hence increases plant yields (Hegazi, 2004). These results are in agreement with those obtained by) Berhanu *et al.,* 2013).

The highest root yield of first season (21.19 Mg $fed.^{-1}$) and of second season (21.33 Mg $fed.^{-1}$), respectively were obtained due to the addition of compost + Zn + B treatment which resulted in relative increments of 28.3% and 25.3% in both seasons, respectively.

Sucrose content and Sugar yield

Values of sucrose percentage and sugar yield as affected by compost, Zn and B whether applied solely or in combinations are shown in Table 5. Sucrose percent varied between 14.65% - 17.86% in the growing of first season and 14.81% - 17.93% in second season growing. It is well known that salinity retards plant growth and yield, then the use of salt tolerance crop has been recognized as a successful method to overcome the salinity problem. For this reason boron application is most important for sugar beet plants grown in saline soils (Meiri and Plaut, 1985). The presence of boron is essential to facilitate sugar transport within plant. Gezgin *et al.* (2001) found that sugar yield was increased by increasing boron fertilizer. Gobarah and Mekki, (2005) reported that boron application at different rates resulting in a significant increases in sucrose content. Armin and Asgharipour (2012) who indicated that highest root yield and sucrose concentration were obtained by spraying with 12% boric acid.Gobarah and Thalooth (2001) found that foliar spraying with different micronutrients significantly increased sugar yield. The plants treated with compost + Zn + B gave the highest sucrose content and sugar yield followed by Zn + B treatment. These results may be attributed to high organic materials and minerals such as N, P, K, Ca, Mg and micro nutrients of compost (Aqeel and Hameed, 2007).

Table 5. Effect of treatments on growth parameters and yield during the two growing seasons.

Treatment	Root length (cm)		Root weight (Kg)		Root yield (Mg fed^{-1})		Sucrose (%)		Sugar yield (Kg fed^{-1})	
	first season	second season	first season	second season	first season	second season	first season	second season	first season	second season
Control	27.6 h	28.2 g	0.52 b	0.54 b	16.5 e	17.0 e	14.7 c	14.8 c	2.42 c	2.44 c
Compost, (CO)	32.3 g	34.0 f	0.69 b	0.71 ab	17.9 d	18.1 d	15.1 c	15.3 c	2.71 bc	2.75 bc
Zn	35.9 e	35.9 e	0.75 b	0.77 ab	18.0 d	18.2 d	15.3 c	15.4 c	2.75 bc	2.77 bc
B	37.8 d	37.9 d	0.80 b	0.85 ab	18.3 d	18.4 d	16.5 b	16.5 b	3.01 bc	3.02 bc
CO+Zn	33.7 f	34.1 f	0.82 b	0.85 ab	18.6 d	18.8 d	15.3 c	15.3 c	2.84 bc	2.86 bc
CO+B	38.5 c	39.9 c	1.29 a	1.30 a	19.5 c	19.9 c	16.7 b	16.8 b	3.25abc	3.27 ab
Zn+B	40.2 b	40.6 b	1.30 a	1.30 a	20.5 b	20.6 b	16.8 b	16.8 b	3.43 ab	3.44 ab
CO+Zn+B	41.9 a	41.9 a	1.31 a	1.31 a	21.2 a	21.3 a	17.9 a	17.9 a	3.78 a	3.81 a
Grand Mean	36.0	36.6	0.935	0.954	18.81	19.03	16.02	16.12	3.024	3.045
$LSD_{0.05}$	0.619	0.499	0.327	0.386	0.695	0.544	0.561	0.468	0.553	0.494

The values were 17.86% and 3.78 Kg $fed.^{-1}$ for the first season giving increases of 21.9% and 56.2%, respectively while the values were 17.93% and 3.81 Kg $fed.^{-1}$ for the second season giving increases of 21.1% and 56.2%, respectively.

Macronutrient content in root.

Data in Tables 6 show that root N, P and K content were increased due to addition of compost, Zn and B and their combinations. Also, the treatment consisting of compost + Zn + B was superior for increasing the content of N, P and K as compared to the other treatments. This promoting effect could be related to the positive effect of organic manures might reflect the different characteristics of the added organic manures (their chemical composition and nutritional status). The organic manures might create favorable soil physical and chemical conditions, which affect the solubility and availability of nutrients and thus uptake of nutritional elements. Moreover, the released N is known to be an essential nutrient for plant growth and development involved in vital plant functions such as photosynthesis, DNA synthesis, protein formation and respiration (Diacono *et al.,* 2013). These results coincide with the results of Abbas *et al.* (2011) and Namvar and Teymur (2013).

The individual effect of compost, Zn and B treatments showed a descending increase in the order: (B > Zn > compost) for N, P and K content by sugar beet roots during the growing seasons first season and second season.The highest values of N, P and K uptake during the two growing seasons were achieved due to application of compost + Zn + B and this was found true for the two growing seasons. On the contrary of that, Na content was decreased due to the added treatments during the two growing seasons.

Table 6. Effect of treatments on root macronutrient contents during the two growing seasons.

Treatment	Macronutrients content (%)							
	N		P		K		Na	
	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015
Control	2.55	2.61	0.25	0.27	3.14	3.16	1.58 a	1.54
Compost, (CO)	2.72	2.75	0.27	0.28	3.18	3.23	1.41 ab	1.39
Zn	2.76	2.79	0.29	0.31	3.22	3.27	1.37 ab	1.35
B	2.82	2.86	0.31	0.33	3.26	3.31	1.33 ab	1.31
CO+Zn	3.01	3.04	0.34	0.35	3.37	3.39	1.31 ab	1.25
CO+B	3.12	3.15	0.36	0.38	3.41	3.44	1.22 ab	1.21
Zn+B	3.15	3.17	0.39	0.41	3.45	3.49	1.21 ab	1.17
CO+Zn+B	3.21	3.24	0.42	0.43	3.48	3.51	1.18 ab	1.16
Grand Mean	2.92	2.95	0.33	0.35	3.31	3.35	1.33	1.30
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	0.234	NS

Micronutrient contents in root.

Values of Fe, Mn, Zn and B content by sugar beet roots as affected by application of compost, Zn and B solely or in combinations were shown in Table 7. The content of Fe, Mn, Zn and B followed a pattern similar to that shown by the macronutrient where they increased significantly by the addition of the aforementioned fertilization treatments during the two growing seasons. Compost + Zn + B treatment was most effective on uptake of Fe, Mn, Zn and B as compared to the other treatments. This trend was found true for the two growing seasons first season and second season .The percentages response of Fe, Mn, Zn and B content by roots over the control were 33.8, 53.0, 120 and 152% in first season and 35.5, 55.7, 97.1 and 133% in second season , respectively. These findings are in agreement with those reported by Ashmaye *et al.* (2008) and Nasef *et al*. (2009) who reported that the application of compost fertilizer caused pronounced increases in soil available micronutrients contents (Fe, Mn , Zn and Cu) during two season under rice cropping.

Table 7. Effect of treatments on root micronutrient contents during the two growing seasons.

Treatment	Micronutrients content (mg kg^{-1})							
	Fe		Mn		Zn		B	
	first season	second season	first season	second season	first season	second season	first season	second season
Control	148 d	152 f	66 f	70 d	30 c	35 d	21 d	24 d
Compost, (CO)	153 d	157 ef	73 e	78 c	38 bc	42 cd	25 d	28 d
Zn	157 cd	162 e	79 de	81 c	46 abc	50 bcd	30 cd	34 c
B	166 c	174 d	85 cd	92 b	50 ab	55 abc	37 bc	39 c
CO+Zn	183 b	186 c	88 bc	95 b	56 ab	61 ab	44 ab	46 b
CO+B	189 ab	195 b	94 ab	98 b	59 a	63 ab	48 ab	52 a
Zn+B	193 ab	199 ab	96 ab	99 b	61 a	67 ab	51 a	54 a
CO+Zn+B	198 a	206 a	101 a	109 a	66 a	69 a	53 a	56 a
Grand Mean	173	179	85	90	51	55	39	42
$LSD_{0.05}$	9.719	7.929	6.598	5.238	14.34	12.35	9.109	5.463

These increases may be attributed to the role of organic materials in improving these micronutrients availability which was likely attributed to several reasons: *i*) Releasing of these nutrients through microbial decomposition of organic matter ; *ii*) Enhancing the chelation of metal ions by fulvic acid, organic legends and / or other organic function groups which may promote the mobility of metal from solid to liquid phase in the soil environment; *iii*) Lowering the redox statues of iron and manganese, leading to reduction of higher Fe^{3+} & Mn^{4+} to Fe^{2+} and Mn^{2+} and / or transformation of insoluble chelated forms into more soluble ions.

CONCLUSION

It could be concluded that application of compost is very important due to its effect on improving soil physical, chemical and biological properties, besides compost represents a storehouse for all essential macro and micronutrients. Also, the foliar application with boron and zinc to sugar beet, especially when it grown in high saline soils is very important, which lead to increase the root yield, yield components and also increased sugar percent and sugar yield. Finally, under the current experimental conditions, it could be concluded that this work hand granted evidence to the effective role of applied compost manure at the rate of 5 Mg ha^{-1} in combination with Zn and B as foliar application to achieve the greatest growth parameters, yield and quality of sugar beet roots grown under salinity and sodicity stresses.

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التأثير المتبادل بين الكمبوست والرش الورقي بالزنك والبورون علي بنجر السكر(*Beta vulgaris L.*) النامي في الأرض الملحية الرملية الطميية

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تم أجراء تجربتين حقليتين بقرية جلبانه رقم (7) ، محافظة شمال سيناء - جمهورية مصر العربية خلال موسم الشتاء لعامين متتالين هما 2014/2013 و 2014/ 2015 وذلك لدراسة التأثير المتبادل لأضافة الكمبوست و الرش الورقي بالعناصر الصغري (الزنك و البورون) وذلك منفردين أو بالتداخل فيما بينهما و تأثير ذلك علي جودة وبعض الصفات المحصولية والأنتاجية ومحتوي العناصر الكبري و الصغري علي نبات بنجر السكر صنف (Mirodor) النامي في الأرض الملحية (الرملية الطميية) وتحسين بعض صفات التربة. وقد أظهرت النتائج أن هناك إنخفاضاً في درجة الملوحة في منطقة أنتشار الجذور كما إنخفض رقم الحموضة بالتربة pH نتيجة للأضافات تحت الدراسة مقارنة بمعاملة المقارنة وذلك خلال موسمي الدراسة. وقد أوضحت النتائج زيادة جميع صفات النمو وكذلك محصول الجذور ومحتواها من العناصري الكبري و الصغري زيادة معنوية خلال موسمي النمو تحت الدراسة نتيجة لإضافة المعاملات المستخدمة. وكانت أعلي القيم المتحصل عليها نتيجة للمعاملة (أضافة الكمبوست بمعدل 5 ميجاجرام / فدان مع الرش الورقي بالزنك والبورون) و التي أعطت أيضا أعلي تركيز للسكروز ومحصول السكر بالجذور وذلك خلال موسمي النمو تحت الدراسة (2014/2013 و 2015/2014).