YIELD AND QUALITY OF SUGAR BEET AS AFFECTED BY NITROGEN SOURCE AND ZINC FERTILIZATION UNDER SALINE SOIL CONDITIONS

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ABSTRACT

Two field experiments were conducted at El-Sirw Agricultural Research Station, Damietta Governorate (latitude of 31.14^{0} N and longitude of 31.39^{0} E) during the two seasons 2011/2012 and 2012/2013 to investigate the effect of different sources of nitrogen and zinc levels on growth, yield and quality of sugar beet crop (*Beta vulgaris* var. saccharifera, L.) grown in saline soil conditions. The present work included eighteen treatments, which were the combinations of six nitrogen source including the sole application of urea (46.5% N), ammonium nitrate (33.5% N), ammonium sulfate (20.6 % N and 24 S%); combined application of 50:50% of urea and ammonium nitrate and 50:50% of urea and ammonium sulphate as well as 50:50% of ammonium nitrate and ammonium sulphate, in addition to three foliar applications of zinc (without zinc, control), 1000 and 2000 ppm as zinc sulphate (22% zinc).

The obtained results showed that fertilizing sugar beet using the sole application of ammonium nitrate and mixture of ammonium nitrate + ammonium sulphate at ratio of 50:50 as nitrogen source produced significant higher root length, diameter, top, root fresh weight, sucrose%, quality %, calcium, magnesium, nitrogen, phosphorus, zinc contents in leaves and zinc uptake in roots as well as root, top and sugar yields/fed compared with that recorded by the other N sources.

Results showed that higher values of root length, diameter, root and top fresh weight/plant, root, top and sugar yields/fed, sucrose% and zinc concentration in root and leaves (ppm) were obtained with increasing foliar zinc application up to 2000 ppm.

The interactions among nitrogen sources and zinc levels significantly affected root, top fresh weight/plant and root yield/fed, where the mixture of ammonium nitrate + ammonium sulphate at ratio of 50:50 in addition to 2000 ppm zinc as foliar application gave the highest value of root, top fresh weight/plant and root yield/fed in both seasons compared with the other nitrogen sources.

Key words: Nitrogen source, zinc, saline soil.

INTRODUCTION

Soil salinity is one of the main agricultural problems limiting plant growth and development, especially in arid and semiarid regions **Pressarakli (2010)**. Salinity disrupts mineral nutrients acquisition by plants through the reduction of nutrient availability by competition with major ions, *e.g.* Na^{+} and Cl^{-}, as the osmotic effect, ionic imbalance and ion toxicity are the main harmful salinity effects that can inhibit plant growth. It is well established that the growth inhibition and the adverse effects induced by salinity can be alleviated by proper fertilization and water management. Hence, excessive nitrogen application, proper rate timing and form of nitrogen application are critical factors in saline soils **(Chen *et al*., 2010)**.

Nitrogen and zinc are essential nutrients required for normal physiological processes of plants. Sugar beet profits are based on three key factors: beet yield, sucrose content and sucrose recovery efficiency. Nutrients can affect all of the three factors, especially nitrogen. Nitrogen nutrition is essential for building up plant organs through the synthesis of proteins; carbohydrates and sucrose which consider as an energy source for plant growth at all growth stages. Cultivars differ in their needs to fertilizers especially nitrogen element, which must be added to plant in the form and methods which make it available to absorption by the plant. **Findenegg *et al*., (1989)** mentioned that higher chloride uptake by sugar beet plants with increasing p^H in salinity and nitrogen interactive studies, the form in which nitrogen is supplied is important. Some studies indicate that increased nitrate in nutrient solution would decrease chloride uptake and its accumulation. **Nemeat Alla *et al*. (2002)** stated that ammonium nitrate significantly increased root length and diameter as well as root and sugar yields compared with urea and ammonium sulphate. They added that nitrogen sources showed no significant effect on sucrose and purity percentages. **Ismail and Abo El-Ghait (2005)** found that the addition of ammonium sulphate positively affected the root length and ammonium nitrate recorded the lowest value of alpha-amino nitrogen %. **Bybordi (2009)** showed that using the appropriate form of nitrogen should be of principal concern and depends upon various factors such as type of crop, soil status and rotation. In salt affected soil, nitrate assimilation is low because cations such as potassium, calcium and magnesium are decreased by increasing ammonium, while nitrate has incremental effect on these cations. It is believed that, for most plant species, nitrate is a preferred as a form of nitrogen under saline conditions. These beneficial effects have been attributed to the antagonism between nitrate and chloride ions. **El-labbody**, ***et al*. (2012)** revealed that using nitrogen source as ammonium nitrate 33.5% N maximized yield productivity, *i.e.* average root weight, root and sugar yields/fed. However, juice impurities were increased as urea was applied as a nitrogen fertilizer source. On the contrary, agradual increase in sucrose% was detected with ammonium sulfate. **Ghazy (2013)** affirmed that nitrogen sources have a significant effect on crop growth rate and net assimilation rate at all growth periods. Ammonium nitrate as a nitrogen source surpassed other nitrogen sources in crop growth rate, sucrose percentage as well as root and sugar yields/fed.

Micronutrients as foliar application are particularly useful under Egyptian soil conditions where, some of it suffer greatly from alkalinity and some suffer from salinity. Therefore, most micronutrients are fixed and become unavailable to plant uptake **(Shalaby**, **1998)**. Zinc is required in small amount for the plant, but it is critical to allow several key plant physiological pathways to function normally. In plants, zinc plays a key role as a structural constituents or regulatory co-factory of a wide rang of different enzymes and proteins in many important biochemical pathways and these are mainly concerned with carbohydrate metabolism, both in photosynthesis and in the conversion of sugars to starch, protein metabolism, auxin metabolism, where it is essential for tryptophan synthesis, which is a prerequisite for auxin formation, therefore amount of auxin decreases under zinc deficiency the maintenance of the integrity of biological membranes, the resistance to infection by certain pathogens **(Alloway**, **2008)**. One of the first indications of zinc deficiency is stunted plants resulting from a shortage of growth regulators. Zinc plays a principal metabolic role in plants and plays a critical role in increasing plant resistance to environmental stresses **(Hisamitsu *et al*.**, **2001** and **Cakmak *et al*.**, **2008)**. Utilizing of fertilizers contain zinc and other micronutrients, performance on quality of crops is increasing and with shortage of this elements due to decline in plant photosynthesis and destroy RNA, amount of solution carbohydrates and synthesis of protein decreased and then performance and quality of crop will be decreased (**Mousavi**, ***et al*. 2011)**.

Successful crop production under saline environments demands on the optimum use of plant nutrients and the appropriate form of nitrogen fertilizer, in addition to other agronomic practices. Objective of this work was to find out the appropriate source of nitrogen and zinc levels to attain the maximum yield and quality of sugar beet Sultan cv. under saline soil conditions.

MATERIALS AND METHODS

Two field experiments were conducted at El-Sirw Agricultural Research Station, Damietta Governorate (latitude of 31.14$^{\mathbf{0}}$ N and longitude of 31.39$^{\mathbf{0}}$ E) during 2011/2012 and 2012/2013 seasons to investigate the effect of different sources of nitrogen and foliar application of zinc levels on growth, yield and quality of sugar beet crop (*Beta vulgaris* var. saccharifera, L.) grown in saline soil condition. The present work included eighteen treatments, which were the combinations of six nitrogen source including the sole application of urea, $CO(NH_2)_2$ containing 46.5 % N, ammonium nitrate, $NH_4(NO_3)$ containing 33.5 % N, ammonium sulfate, $(NH_4)_2SO_4$ containing 20.6 % N and 24 S%; combined application of 50:50% of urea and ammonium nitrate and 50:50% of urea and ammonium sulphate as well as 50:50% of ammonium nitrate and ammonium sulphate. Nitrogen treatments were applied at rate of 80 kg N/fed in two equal doses, after thinning and one month later. In addition, three concentrations of zinc (without zinc, control), 1000 and 2000 ppm as zinc sulphate heptahydrate ($ZnSO_4.7H_2O$, containing 22% zinc), sprayed after thinning and 75 days later. A split-plot design in four replications was used. The six nitrogen treatments were allocated in the main plots and the three levels of zinc were randomly distributed in the sub-plots. The sub-plot size was 10.5 m^2 included 5 ridges, 3.5 m in length and 60 cm in width, and 20 cm between hills. Phosphorus fertilizer was applied in the form of calcium super phosphate (15 % P_2O_5) at the rate of 200 kg/fed at seed bed preparation. Potassium fertilizer was added in the form of potassium sulphate (48% K_2O) at the rate of 48 kg/fed before canopy closer. Sowing took place during the 2nd week of September, while harvesting was done 7 months later in both seasons. Plants were thinned at 4-leaf stage to ensure one plant per hill. The commercial sugar beet variety "Sultan" was used in both seasons.

Some physical properties were analyzed using the procedure described by **Black *et al*. (1981)**. Soil chemical analysis was determined according to the method described by **Jackson (1973)**. Some physical and chemical analyses of the soil (the upper 30-cm) of the experimental site are given in Table 1.

Table (1): particle size distribution and some chemical properties of a representative soil sample of the experimental site for 2011-2012 and 2012-2013 seasons.

Soil property	**2011/2012 season**	**2012/2013 season**
Particle size distribution:		
Sand %	23.94	25.63
Silt %	25.11	23.81
Clay %	50.95	50.56
Texture class	clay	clay
Available nutrients		
Organic Matter %	1.49	1.62
Available Nitrogen mg/kg soil	49.87	50.24
Available P_2O_5 mg/kg soil	6.55	7.24
Available K_2O mg/kg soil	298.8	282.0
Available zinc mg/kg soil	0.22	0.27
pH at (1:2.5) soil : water suspension	7.95	8.14
EC dS/m^{-1}	7.41	7.79
Soluble Cations meq/L^{-1}		
k^+	2.00	2.49
Na^+	38.5	37.7
Mg^{++}	15.0	17.2
Ca^{++}	18.5	20.4
Soluble Anions meq/L^{-1}		
$So_4^=$	23.70	24.79
Cl^-	45.3	47.9
HCO_3^-	5.0	5.1
$CO_3^=$	-	-
SAR %	9.39	8.69
ESP %	13.15	12.17

The recorded data:

1. Root length and diameter (cm).
2. Root and top fresh weight (g/plant).
3. Dry matter accumulation: each sample was separated into blades, petioles and roots. The 100 g of plant fractions were oven dried to constant weight for 48 hours at 70^0 C.
4. Root and/or leaf dry weight (g/plant) was calculated as follows:

Root and/or leaf dry weight = root and/or leaves dry matter% x root and/or top fresh weight.

At harvest, plants of two guarded rows were uprooted, topped and weighed to determine the following parameters:

1. Top yield (ton/fed).
2. Root yield (ton/fed).
3. Recoverable sugar yield (ton/fed), which was calculated according to following equation:

Recoverable sugar yield (ton/fed) = roots yield (ton/fed) x sugar recovery%.

Juice quality and chemical constituents:

1. Sucrose percentage (Pol%) was estimated in fresh samples of sugar beet roots, using Saccharometer according to the method described in **AOAC**, **(2005)**.
2. Sugar loss to molasses percentage (SLM %) was calculated by formula according to **Devillers**, **(1988)** as follows:

SLM% = 0.29 + (Na + K) 0.343 + 0.094 (α-amino N).

3. Sugar recovery % was calculated using the following equation according to **Cooke** and **Scott**, **(1993)**.

Sugar recovery % = (Pol % - 0.29) - 0.343(K + Na) - α- amino N (0.0939).

Where: K, Na and α-amino N were determined as meq/100 g beet.

4. Juice quality percentage (QZ %) was calculated according to **Cooke** and **Scott**, **(1993)** using the following equation:

Q Z % = (sugar recovery % x100)/Pol %.

5. Impurities%: K, Na and α-amino N contents were estimated as meq/100 g beet according to the procedure of sugar company by Automated Analyzer as described in **Cooke** and **Scott**, **(1993)**.
6. The plant material (leaves) was digested using an acid mixture consisting of nitric, perchloric and sulfuric acids in the ratio of 8:1:1 (v/v), respectively **(Chapman and Pratt**, **1978)**. Nitrogen (N) was determined using the boric acid modification described by **Ma and Zuazage (1942**), and distillation was done using Gerhardt apparatus. Phosphorus was photometrically determined using the molybdate vanadate method according to **Jackson (1973**). Calcium was determined using flame photometer (Genway). Magnesium and (Zinc in leaves and roots) were determined using the Atomic absorption spectrophotometer (Perkin Elemer 100 B).

Data obtained were statistically analyzed according to the method described by **Gomez and Gomez (1984)**. A combined analysis of the two seasons was done according to **Le-Clerg *et al*. (1966)**. All statistical analysis was perforrmed using analysis of variance technique of **(MSTATC)** computer software package.

RESULTS AND DISCUSSION

Soil analysis:

Results in Table 1 summarized the physical and chemical characteristics of the soil at 2011/2012 and 2012/2013 seasons where experiments were done. The soil was clay in texture, alkaline, low in reaction. The EC value was high, according to the tentative values of available nutrient concentration by **Ankerman and Large (1974)**. Data presented in Table 1 showed that soil had N, P, K and Zn (mg/kg soil) available ranged between low and medium content. As well as the soluble cations (meq/l) was marked by the rule of sodium cation followed by calcium and magnesium and potassium, while soluble anions (meq/l) were characterized by the rule of chloride anion followed by sulfate and bicarbonate. Sodium Adsorption Ratio (SAR) and Exchangeable Sodium Percentage (ESP) were less than 15 in both seasons. From the above mentioned results, it could be noticed that the studied soil condition was saline.

1. **Root length**, **diameter and root fresh weight**:

Results in Table 2 indicated that root length, diameter and fresh weight/plant of sugar beet were significantly affected by the sole and combined application of the used nitrogen, in both seasons and their combined analysis. With regard to the effect of individual nitrogen sources, it was found that fertilizing sugar beet with ammonium nitrate produced longer, thicker and heavier roots compared with those given by applying urea and ammonium sulphate. On the other hand, supplying sugar beet with a mixture of ammonium nitrate and ammonium sulphate at ratio of 50:50 resulted in a positive effect on these traits. These results may be refer to that under conditions of salinity affected soils, where Na^+ and Ca^{++} cations are abundant, the opportunity of losing ammonium nitrate decreases. Meantime, the abundance of Cl^- anion, which hinder the conversion of ammonium to nitrate, and hence, ammonium sulphate competes with other cations as Ca^{++} and Mg^{++}, leading to the reduction of the available amounts of these elements. Therefore, under such conditions, plants suffer from of unavailability of nitrogen and water. Moreover, under saline conditions, where the p^H is high, the applied urea is lost by volatization. These findings are in agreement with those recorded by **Nemeat Alla**, ***et al*. (2002)**, **Bybordi (2009)**, **El-labbody**, ***et al*. (2012)** and **Ghazy (2013)**.

Table 2: **Root length (cm)**, **root diameter (cm) and root fresh weight (g/plant) as affected by the sole and combined application of nitrogen sources and zinc fertilization levels in 2011/2012 and 2012/2013 seasons and their combined**.

Nitrogen treatments	Root length		Comb.	Root diameter		Comb.	Root fresh weight		Comb.
	1st season	2nd season		1st season	2nd season		1st season	2nd season	
Urea	25.33	26.60	25.97	8.15	8.23	8.19	398.70	401.22	399.96
AN	28.55	28.69	28.62	9.01	9.17	9.09	495.40	483.89	489.64
AS	25.96	27.46	26.71	8.50	8.77	8.64	429.67	408.11	418.89
Urea +AN	27.78	28.14	27.96	9.05	9.00	9.03	462.91	490.61	476.76
Urea+ AS	27.30	27.49	27.40	8.35	8.37	8.36	439.25	416.89	428.07
AN + AS	30.39	29.36	29.87	9.89	9.94	9.92	554.38	569.67	562.02
LSD	**2.57**	**1.21**	**0.77**	**0.80**	**0.90**	**0.39**	**57.52**	**65.51**	**26.43**
Without Zinc	26.05	27.34	26.70	8.05	8.34	8.20	407.91	389.39	398.65
Zinc 1	27.57	27.91	27.74	8.86	9.01	8.93	459.62	459.72	459.67
Zinc 2	29.04	28.63	28.83	9.57	9.39	9.48	522.63	536.08	529.36
LSD	**0.46**	**0.34**	**0.54**	**0.32**	**0.29**	**0.27**	**17.03**	**21.43**	**18.69**

Urea : $CO(NH_2)_2$ containing 46.5 % N was applied as a sole.
A.N.: Ammonium nitrate $NH_4(NO_3)$ containing 33.5 % N was applied as a sole.
A.S.: Ammonium sulfate $(NH_4)_2SO_4$ containing 20.6 % N and 24 S%, was applied as a sole.
Without zinc (Control): Sugar beet plants were sprayed with water.
Zinc 1: 1000 ppm zinc as foliar application in the form of zinc sulphate after thinning and one 75 days later.
Zinc 2: 2000 ppm zinc as foliar application in the form of zinc sulphate after thinning and one 75 days later.

Concerning the effect of zinc levels, data in the same table indicated that root length, diameter and fresh weigth/plant of sugar beet significantly increased by increasing the sprayed zinc levels in the 1st or 2nd seasons and their combined. It was found that fertilizing sugar beet with 2000 ppm of zinc attaind longer, thicker and heavier roots compared to those given 1000 ppm of zinc and unfertilized plants. The positive influence of the applied levels of zinc may be due to the shortage of this element in the experimental site (Table 1), hence the important role of zinc element, which improved plant growth and elongation due to the role of zinc in tryptophan biosynthesis, acting as precursor of auxin **(Hisamitsu *et al*., 2001** and **Cakmak *et al*., 2008)**.

Interaction effect:

Root fresh weight/plant (RFW) was singnificantly affected by the interaction between nitrogen treatments and zinc concentrations. The results in Table 3 showed that the difference in RFW between beets sprayed with 1000 ppm of zinc and those untreated with zinc was insignificant, when plants were fertilized with a combination of urea + AN, however, the variance in RFW between these two levels of zinc was significant under conditions of the other combinations of nitrogen treatments, in the 1st season. In the 2nd season one, insignificant variance in RFW was detected between the unfertilized plants and those supplied with 1000 ppm of zinc, in case of feeding both of them with nitrogen as AN. Meanwhile, the difference in this traits as affected by the two levels of zinc reached the level of significance under conditions of the other studied N sources and/or combinations.

Table 3: **Root fresh weight (g/plant) as affected by the interaction among nitrogen treatments and zinc levels in 2011/2012 and 2012/2013 seasons**.

Nitrogen treatments	2011/ 2012 seasons			2012/ 2013 seasons		
	Without Zinc	1000 ppm zinc	2000 ppm zinc	Without Zinc	1000 ppm zinc	2000 ppm zinc
Urea	306.43	393.33	496.33	343.33	396.67	463.67
Ammonium nitrate	448.00	491.33	546.87	432.00	473.00	546.67
Ammonium sulphate	383.33	424.00	481.67	351.33	404.67	468.33
Urea + AN	433.07	452.33	503.33	409.00	456.33	606.50
Urea+ AS	393.27	432.92	491.57	346.00	443.00	461.67
AN + AS	483.33	563.80	616.00	454.67	584.67	669.67
LSD at 0.05% level for:			**41.71**			**52.48**

Urea : CO $(NH_2)_2$ containing 46.5 % N was applied as a sole.
A.N.: Ammonium nitrate NH_4 (NO_3) containing 33.5 % N was applied as a sole.
A.S.: Ammonium sulfate $(NH_4)_2SO_4$ containing 20.6 % N and 24 S%, was applied as a sole.
Without zinc (Control): Sugar beet plants were sprayed with water.
Zinc 1 : 1000 ppm zinc as foliar application in the form of zinc sulphate after thinning and one 75 days later.
Zinc 2 : 2000 ppm zinc as foliar application in the form of zinc sulphate after thinning and one 75 days later.

2. **Top fresh weight/plant**, **root and top dry weight/plant**:

The combined analysis of the two growing seasons in Table 4 manifested a significant effect of nitrogen forms on sugar beet top fresh weight/plant, root and top dry weight/plant. Fertilizing sugar beet with ammonium nitrate produced higher values of top fresh weight and caused an appreciable increase in top and root dry weight/plant compared with those produced by supplying plants with urea and ammonium sulphate as sole application. This may be due to the fact that ammonium nitrate can be readily absorbed by the plant, where it doesn't need to undergo any further conversion, as is the case with urea and ammonium sulphate, before plant up-take, besides that the conversion of nitrates to amino acids occurs in leaves. This process is fuelled by solar energy, which makes it an energy-efficient process, while ammonium has to be converted into organic nitrogen compounds in roots. This process is fuelled by carbohydrates, which are at the expense of other plant life process. Thus enhancing the assimilate availability in leaves and roots and in tern increased its biomass.

On the other hand, supplying sugar beet with a mixture of ammonium nitrate and ammonium sulphate at ratio of 50:50 resulted in consistently positive effect on these traits compared with other combinations. These results may be refer to the integration between the comparative advantage of the used ammonium nitrate with comparative advantage in ammonium sulphate fertilization in terms of decreases in soil pH more rapidly than most other forms of nitrogen. This guaranteed a suitable growth condition and hence a rapid growth of the plant, especially under harmful salinity effect, which in turn was reflected on the final root and top yields at harvest. These results can also be attributed to enhancing the assimilate availability in leaves and roots and in turn increased its biomass. As for the effect of zinc levels, data in the same table cleared that top fresh weight/plant (TFW), increased significantly by raising the applied zinc levels in 1st and 2nd seasons and their combined. Application of 2000 ppm of zinc resulted in the highest values of top fresh weight/plant compared to the other zinc treatments. Increasing zinc level up to 2000 ppm led to an increase in TFW amount to 73.86 and 36.00 g/plant compared to that gained by plants untreated with zinc and that fertilized with 1000 zinc respectively, according to the combined analysis. These results were mainly due to the enhancing role of zinc as shown by (**Alloway**, **2008)**. In addition, the application of zinc concentrations insignificantly affected root, top dry weight/plant in both season and their combined.

Table (4): **Top fresh weight (g/plant)**, **root and top dry weight (g/plant) as affected by the sole and combined application of nitrogen sources and zinc ertilization levels in 2011/2012 and 2012/2013 seasons and their combined**.

Nitrogen treatments	Top fresh weight		Comb.	Root dry weight		Comb.	Top dry weight		Comb.
	1st season	2nd season		2nd season	2nd season		1st season	2nd season	
Urea	227.66	236.00	231.83	14.43	15.47	14.95	9.51	7.82	8.67
AN	286.97	299.44	293.21	18.46	17.30	17.88	11.25	8.72	9.99
AS	247.76	252.11	249.93	14.60	15.77	15.18	10.07	8.29	9.18
Urea +AN	270.40	265.56	267.98	16.72	17.78	17.25	11.27	8.69	9.98
Urea+ AS	232.67	241.22	236.94	12.93	16.22	14.58	9.46	7.26	8.36
AN + AS	326.33	330.00	328.17	20.48	19.79	20.14	12.99	9.38	11.18
LSD	**34.20**	**20.63**	**12.83**	**3.74**	**1.59**	**1.10**	**1.70**	**0.74**	**0.60**
Without zinc	234.75	227.33	231.04	16.06	16.70	16.38	10.49	8.16	9.32
Zinc 1	264.39	271.78	268.09	16.35	17.19	16.77	10.75	8.37	9.56
Zinc 2	296.75	313.06	304.90	16.40	17.27	16.84	11.03	8.55	9.79
LSD	**8.95**	**12.01**	**9.07**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Urea : CO $(NH_2)_2$ containing 46.5 % N was applied as a sole.
A.N.: Ammonium nitrate NH_4 (NO_3) containing 33.5 % N was applied as a sole.
A.S.: Ammonium sulfate $(NH_4)_2SO_4$ containing 20.6 % N and 24 S%, was applied as a sole.
Without zinc (Control): Sugar beet plants were sprayed with water.
Zinc 1 : 1000 ppm zinc as foliar application in the form of zinc sulphate after thinning and one 75 days later.
Zinc 2 : 2000 ppm zinc as foliar application in the form of zinc sulphate after thinning and one 75 days later.

Interaction effect:

Table (5): **Top fresh weight (g/plant) as affected by the interaction between nitrogen treatments and zinc levels in 2011/2012 and 2012/2013 seasons**.

Nitrogen treatments	2011/ 2012 seasons			2012/ 2013 seasons		
	Without Zinc (control)	**1000 ppm zinc**	**2000 ppm zinc**	**Without zinc (control)**	**1000 ppm zinc**	**2000 ppm zinc**
Urea	205.00	217.00	241.00	203.00	235.00	270.00
Ammonium nitrate	236.90	288.77	325.23	221.67	316.67	360.00
Ammonium sulphate	219.83	232.47	270.97	213.00	250.00	293.33
Urea + AN	231.43	267.00	302.77	226.67	266.67	303.33
Urea+ AS	206.33	226.13	245.53	219.67	239.00	265.00
AN + AS	272.33	318.33	356.67	280.00	323.33	386.67

LSD at 0.05% level for: **21.92** **29.41**

Urea : CO $(NH_2)_2$ containing 46.5 % N was applied as a sole.
A.N.: Ammonium nitrate NH_4 (NO_3) containing 33.5 % N was applied as a sole.
A.S.: Ammonium sulfate $(NH_4)_2SO_4$ containing 20.6 % N and 24 S%, was applied as a sole.
Without zinc (Control): Sugar beet plants were sprayed with water.
Zinc 1 : 1000 ppm zinc as foliar application in the form of zinc sulphate after thinning and one 75 days later.
Zinc 2 : 2000 ppm zinc as foliar application in the form of zinc sulphate after thinning and one 75 days later.

Data in Table 5 showed that the difference in top fresh weight between beets sprayed with 1000 ppm of zinc and those untreated with zinc was insignificant, when plants were fertilized with urea solely, ammonium sulphate solely and a combination of Urea + AS, however, the variance in top fresh weight between those two levels of zinc was significant under conditions of the other nitrogen treatments, in the 1st season. In the 2nd one, there was insignificant variance in this trait between the unfertilized plants and those supplied with 1000 ppm of zinc, in case of feeding both of them with a combination of urea + AS. In the same time, the difference in this trait, as affected by the two levels of zinc, reached the level of significance under conditions of the other studied nitrogn forms and/or combinations.

3. Root, top yields/fed and content of nitrogen in leaves/plant:

Table (6): Root and top yields (ton/fed) and content of nitrogen in leaves (mg/plant) as affected by the sole and combined application of nitrogen sources and zinc fertilization levels in 2011/2012 and 2012/2013 seasons and their combined.

Nitrogen treatments	Root yield		Comb.	Top yield		Comb.	Content of nitrogen		Comb.
	1st season	2nd season		1st season	2nd season		1st season	2nd season	
Urea	19.80	19.77	19.79	8.02	8.00	8.01	43.88	37.32	40.60
A. nitrate	20.38	20.18	20.28	8.63	8.48	8.56	61.90	52.63	57.26
A. sulphate	20.13	20.02	20.08	8.20	8.30	8.25	52.83	44.90	48.87
Urea + AN	20.41	20.35	20.38	8.71	8.40	8.55	65.57	48.02	56.79
Urea+ AS	20.12	20.10	20.11	8.26	8.04	8.15	47.32	30.09	38.71
AN + AS	20.71	20.60	20.66	9.20	8.71	8.95	83.31	63.28	73.30
LSD	**0.28**	**0.24**	**0.12**	**0.42**	**0.29**	**0.22**	**17.64**	**15.10**	**7.32**
Without zinc	19.63	19.91	19.77	8.10	7.89	8.00	58.23	44.19	51.21
Zinc 2	20.37	20.16	20.27	8.41	8.32	8.36	58.78	44.96	51.87
Zinc 3	20.78	20.44	20.61	8.99	8.77	8.88	60.40	48.97	54.69
LSD	**0.11**	**0.07**	**0.08**	**0.26**	**0.19**	**0.16**	**NS**	**NS**	**NS**

Urea : CO $(NH_2)_2$ containing 46.5 % N was applied as a sole.
AN.: Ammonium nitrate NH_4 (NO_3) containing 33.5 % N was applied as a sole.
AS.: Ammonium sulfate $(NH_4)_2SO_4$ containing 20.6 % N and 24 S%, was applied as a sole.
Without zinc (Control): Sugar beet plants were sprayed with water.
Zinc 1 : 1000 ppm zinc as foliar application in the form of zinc sulphate after thinning and one 75 days later.
Zinc 2 : 2000 ppm zinc as foliar application in the form of zinc sulphate after thinning and one 75 days later.

Data in Table 6 showed a significant effect on root, top yields/fed and content of nitrogen in leaves/plant of sugar beet due to the fertilization with the sole and mixture of nitrogen forms. Fertilizing sugar beet with ammonium nitrate gave higher values of these traits compared with those given urea and ammonium sulphate solely. This finding indicates the relative advantage of using ammonium nitrate, where plants fertilized with it were longer and thicker than those fertilized with urea and/or ammonium sulphate (Table 2) which in turn was reflected on root yield at harvest. The positive effect of fertilizing sugar beet with ammonium nitrate has been recorded by **El-labbody**, ***et al*. (2012)** and **Ghazy (2013**). On the other hand, supplying sugar beet with a mixture of ammonium nitrate and ammonium sulphate at ratio of 50:50 resulted in a positive effect on these traits compared with other combinations. These results may be refer to integration between the advantage of using ammonium nitrate with advantage of ammonium sulphate fertilization in terms of decreasing soil pH more rapidly than the other forms of nitrogen, which guaranteed a favorable growth conditions. In this concern **Dreihem and pilbeam (2002)** suggested that the form of nitrogen up-take was influence significant on the characteristics of growth. Application of mixed No_3^-/NH_4^+ was reported to produce higher yields under saline condition.

The results showed that fertilizing sugar beet with 2000 ppm of zinc recorded a significant increase in values of root; top yields/fed in both seasons and their combined. The positive influence of the applied levels of zinc may be due to the shortage of this element in the experimental site (Table 1). However, the result revealed that content nitrogen in leaves/plant was insignificantly influenced by the sprayed concentration of zinc in both season and their combined.

Interaction effect :

Table (7): **Root yield (ton/fed) as affected by the interaction between nitrogen treatments and zinc levels in 2011/2012 and 2012/2013 seasons**.

Nitrogen treatments	2011/ 2012 seasons			2012/ 2013 seasons		
	Without Zinc (control)	1000 ppm zinc	2000 ppm zinc	Without Zinc (control)	1000 ppm zinc	2000 ppm zinc
Urea	19.43	19.75	20.22	19.47	19.77	20.08
Ammonium nitrate	19.65	20.50	21.01	19.90	20.13	20.49
Ammonium sulphate	19.59	20.22	20.58	19.78	20.04	20.24
Urea + AN	19.63	20.60	21.01	20.20	20.34	20.51
Urea+ AS	19.52	20.27	20.58	19.88	20.11	20.30
AN + AS	19.97	20.89	21.28	20.20	20.58	21.03
LSD at 0.05% level for:			**0.26**			**0.17**

Urea : $CO (NH_2)_2$ containing 46.5 % N was applied as a sole.
A.N.: Ammonium nitrate $NH_4 (NO_3)$ containing 33.5 % N was applied as a sole.
A.S.: Ammonium sulfate $(NH_4)_2SO_4$ containing 20.6 % N and 24 S%, was applied as a sole.
Without zinc (Control): Sugar beet plants were sprayed with water.
Zinc 1 : 1000 ppm zinc as foliar application in the form of zinc sulphate after thinning and one 75 days later.
Zinc 2 : 2000 ppm zinc as foliar application in the form of zinc sulphate after thinning and one 75 days later.

With regarded to the influence of interaction between nitrogen treatments and zinc levels in Table 7, the difference in root yield/fed between beets sprayed with 1000 ppm of zinc and those untreated with zinc was insignificant, when plants were fertilized with a combination of urea + AN, in 2nd season only. However, the variance in this trait between the two levels of zinc was significant under conditions of the other forms of nitrogen treatments in both seasons. In addition, rasining zinc levels from zero to 2000 ppm resulted in a significant increase in root yield/fed amounted to 1.36 and 0.59 (tons/fed) in the 1st and 2nd season, respectively, when sugar beet was fertilized with ammonium nitrate individually. Howerver, this increase was 1.31 and 0.83 (tons/fed), when sugar beet was supplied with a mixture of ammonium nitrate and ammonium sulphate at ratio of 50:50, in the 1st and 2nd season, respectively.

4. **Calcium**, **magnesium and chloride contents in leaves/plant**:

The combined analysis of the two growing seasons in Table 8 pointed out a significant effect of sole and combined application of the used nitrogen sources on calcium, magnesium and chloride contents in leaves/plant. Ammonium nitrate solely or mixed with ammonium sulphate at 50:50 ratio had an incremental effect on these cations. It is believed that for most plant species, ammonium nitrate is preferred form under saline conditions, where nitrates synergistically promote the up-take of cations such as calcium and magnesium. In the same line **Irshad *et al*.**, **(2002)** found that the concentration of cation was higher by fertilized with nitrate-treated plants than in other forms, where using ammonium sulphate and/or urea tended to inhibit the up-take of cations compared to nitrate-N under saline conditions. In the same Table, data declared that chloride anion increased when sugar beet was fertilized with urea and ammonium sulphate solely or as mixtures of ammonium nitrate + urea, as well as urea + ammonium sulphate. These results may be due to that chlorine ions in saline soils had antagonistic effects on nitrate uptake, where ammonium nitrate limit the up-take of harmful elements such as chloride, into large quantities (**Findenegg *et al*. 1989)**.

The results showed that these elements were insignificantly influenced by the applied zinc levels.

Table (8): **Calcium**, **magnesium and chloride contents (mg/plant) in leaves/plant as affected by the sole and combined application of nitrogen sources and zinc fertilization levels in 2011/2012 and 2012/2013 season and their combined**.

Nitrogen treatments	Leaves calcium content (mg/plant)		Comb.	Leaves magnesium content (mg/plant)		Comb.	Leaves chloride content (mg/plant)		Comb.
	1st season	2nd season		1st season	2nd season		1st season	2nd season	
Urea	42.67	39.71	41.19	37.62	30.31	33.97	69.06	55.44	62.25
A. nitrate	60.31	53.88	57.10	49.72	35.57	42.65	63.28	41.57	52.43
A. sulphate	42.19	43.60	42.90	36.69	32.66	34.68	78.95	54.99	66.97
Urea + AN	50.70	44.90	47.80	48.55	34.61	41.58	68.48	47.39	57.94
Urea+ AS	33.12	33.89	33.51	33.79	24.88	29.34	83.52	61.76	72.64
AN + AS	69.62	55.54	62.58	58.43	41.13	49.78	58.10	44.80	51.45
LSD	**17.44**	**9.02**	**6.86**	**9.53**	**4.67**	**4.82**	**14.95**	**12.59**	**7.36**
Without zinc	47.09	42.87	44.98	43.92	30.74	37.33	67.33	48.41	57.87
Zinc 2	50.74	45.88	48.31	44.04	33.20	38.62	70.38	50.67	60.52
Zinc 3	51.48	47.02	49.25	44.44	35.64	40.04	72.99	53.90	63.44
LSD	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Urea : CO $(NH_2)_2$ containing 46.5 % N was applied as a sole.
A.N.: Ammonium nitrate NH_4 (NO_3) containing 33.5 % N was applied as a sole.
A.S.: Ammonium sulfate $(NH_4)_2SO_4$ containing 20.6 % N and 24 S%, was applied as a sole.
Without zinc (Control): Sugar beet plants were sprayed with water.
Zinc 1 : 1000 ppm zinc as foliar application in the form of zinc sulphate after thinning and one 75 days later.
Zinc 2 : 2000 ppm zinc as foliar application in the form of zinc sulphate after thinning and one 75 days later.

5. **Zinc uptake by roots, zinc and phosphorus contents in leaves/plant**:

Data in Table 9 revealed that fertilizing sugar beet plants with ammonium nitrate solely increased significantly the uptake of zinc by roots and the content of zinc in leaves compared to that fertilized with urea and ammonium sulphate given as a sole application. Fertilizing beets with ammonium nitrate and ammonium sulphate recorded higher values of phosphorus in leaves compared to that fertilized with urea. The combined analysis cleared the superiority of the combination of ammonium nitrate + ammonium sulphate over the rest of nitrogen combinations, followed by the combination of ammonium nitrate + urea.

Zinc uptake by roots and zinc contents in leaves was appreciably increased by increasing the sprayed zinc concentration in the 1st and 2nd seasons as well as their combined. It was found that fertilizing sugar beet with 2000 ppm of zinc attaind 15.38% and 9.52% higher in zinc uptake by roots and zinc contents in leaves, respectivelly, compared to that given 1000 ppm zinc (combined). However, the appliction of zinc did not significantly affect phosphorus content in leaves in both seasons and their combined. These results were in agrreement with those found by **Mousavi (2011)**.

Table (9): **Zinc uptake by roots, zinc and phosphorus contents (mg/plant) in leaves/plant as affected by the sole and combined application of nitrogen sources and zinc fertilization levels in 2011/2012 and 2012/2013 seasons and their combined.**

Nitrogen treatments	Root zinc content (mg/plant)		Comb.	Leaves zinc content (mg/plant)		Comb.	Leaves phosphorus content (mg/plant)		Comb.
	1st season	2nd season		1st season	2nd season		1st season	2nd season	
Urea	0.49	0.43	0.46	0.18	0.18	0.18	18.25	15.07	16.66
A. nitrate	0.95	0.62	0.78	0.25	0.21	0.23	21.79	20.78	21.28
A. sulphate	0.67	0.51	0.59	0.22	0.19	0.20	21.58	19.94	20.76
Urea + AN	0.67	0.56	0.61	0.23	0.21	0.22	20.63	19.05	19.84
Urea+ AS	0.41	0.44	0.42	0.19	0.16	0.17	17.35	15.52	16.43
AN + AS	0.94	0.67	0.80	0.29	0.24	0.26	23.98	23.95	23.96
LSD	**0.25**	**0.10**	**0.10**	**0.05**	**0.02**	**0.01**	**3.17**	**4.80**	**2.35**
Without zinc	0.56	0.53	0.54	0.21	0.18	0.19	19.94	19.51	19.72
Zinc 1	0.69	0.62	0.65	0.23	0.19	0.21	20.98	18.65	19.81
Zinc 2	0.81	0.70	0.75	0.24	0.22	0.23	20.87	18.99	19.93
LSD	**0.11**	**0.07**	**0.07**	**0.01**	**0.01**	**0.01**	**NS**	**NS**	**NS**

Urea : $CO(NH_2)_2$ containing 46.5 % N was applied as a sole.
A.N.: Ammonium nitrate $NH_4(NO_3)$ containing 33.5 % N was applied as a sole.
A.S.: Ammonium sulfate $(NH_4)_2SO_4$ containing 20.6 % N and 24 S%, was applied as a sole.
Without zinc (Control): Sugar beet plants were sprayed with water.
Zinc 1 : 1000 ppm zinc as foliar application in the form of zinc sulphate after thinning and one 75 days later.
Zinc 2 : 2000 ppm zinc as foliar application in the form of zinc sulphate after thinning and one 75 days later.

6. Sucrose percentage, potassium and sodium contents/beet:

The combined analysis of the two growing seasons in Table 10 pointed to a significant effect of nitrogen sources on sucrose percentage, potassium and sodium contents/beet. Fertilizing sugar beet with ammonium nitrate individually gave higher values of sucrose percentage followed by ammonium sulphate solely, compared to the fertilizition of beets with urea individually. On the other hand, fertilizing sugar beet with a mixture of ammonium nitrate + ammonium sulphate at a ratio of 50:50 resulted in positive effects on these traits, followed by the conbination of urea + ammonium nitrate, compared to the mixture of urea + ammonium sulphate at 50:50 ratio. These findings may be due to that the addition of_ammonium nitrate led to higher uptake of potassium than sodium, which_may led to an increase in sucrose percentage due to the role of potassium in the transfer of sucrose from leaves to roots. In addition, this enhancement can be related to increased root and top dry weight, which contained sucrose as a major portion (Table 4). This results are in agreement with those repoted by **Nemeat Alla**, ***et al*. (2002)** and **El-labbody**, ***et al*. (2012)**. As for potassium and sodium contents/beet, data in the same table cleard that these two elements were significantly affected by the sole and combined application of the used nitrogen. Meantime, fertilization by ammonium sulphate solely and the combination of urea + ammonium sulphate led to a lower values of potassium content and higher values of sodium in both season and their combined.

Table (10): Sucrose percentage, potassium and sodium contents (meq/100 g beet) as affected by the sole and combined application of nitrogen sources and zinc fertilization levels in 2011/2012 and 2012/2013 seasons and their combined.

Nitrogen treatments	Sucrose %		Comb.	Potassium (meq/100 g beet)		Comb.	Sodium (meq/100 g beet)		Comb.
	1st season	2nd season		1st season	2nd season		1st season	2nd season	
Urea	15.38	15.33	15.36	3.45	3.43	3.44	2.32	2.39	2.36
A. nitrate	15.92	15.80	15.86	3.53	3.49	3.51	2.09	2.15	2.12
A. sulphate	15.64	15.56	15.60	3.35	3.30	3.33	2.48	2.47	2.48
Urea + AN	15.97	15.86	15.92	3.48	3.47	3.47	2.24	2.37	2.30
Urea+ AS	15.41	15.52	15.47	3.31	3.37	3.34	2.52	2.54	2.53
AN + AS	16.21	16.11	16.16	3.41	3.46	3.44	2.18	2.26	2.22
LSD	**0.23**	**0.21**	**0.11**	**0.10**	**0.09**	**0.04**	**0.09**	**0.08**	**0.04**
Without zinc	15.53	15.42	15.48	3.42	3.43	3.42	2.31	2.36	2.34
Zinc 1	15.74	15.71	15.73	3.43	3.42	3.43	2.30	2.37	2.33
Zinc 2	16.00	15.96	15.98	3.41	3.41	3.41	2.29	2.35	2.32
LSD	**0.13**	**0.08**	**0.08**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Urea : $CO (NH_2)_2$ containing 46.5 % N was applied as a sole.
A.N.: Ammonium nitrate $NH_4 (NO_3)$ containing 33.5 % N was applied as a sole.
A.S.: Ammonium sulfate $(NH_4)_2SO_4$ containing 20.6 % N and 24 S%, was applied as a sole.
Without zinc (Control): Sugar beet plants were sprayed with water.
Zinc 1 : 1000 ppm zinc as foliar application in the form of zinc sulphate after thinning and one 75 days later.
Zinc 2 : 2000 ppm zinc as foliar application in the form of zinc sulphate after thinning and one 75 days later.

The results in Table 10 showed higher values of sucrose percentage by increasing the sprayed zinc level to 2000 ppm in 1st and 2nd seasons. The combined analysis showed a significant increase in sucrose % of 0.25 % and 0.50 %, by increasing zinc level to 1000 and 2000 ppm compared the check treatment, respectively. These finding are in agreement with those reported by **Cakmak**, **(2008)** and **Mousavi**, **(2011)**. However, the application of zinc did not significantly affect potassium and sodium contents in both seasons and their combined.

7-Alpha-amino nitrogen content/beet, **sugar recovery and sugar loss to molasses percentages**:

The combined analysis of the two growing seasons in Table 11 revealed that alpha amino nitrogen content/beet, sugar recovery and sugar loss to molasses percentages, were significantly affected by the sole and combined application of the used nitrogen. Meantime, the fertilization with urea solely, ammonium sulphate solely and combination of urea + ammonium sulphate led to a higher values of alpha-amino nitrogen content compared to the use of ammonium nitrate singly or in a mixture with ammonium sulphate. These observations coincide with those found by **Ismail and Abo El-Ghait (2005)**. Data in the same table cleared significant differences among forms of nitrogen fertilization used on sugar recovery and sugar loss to molasses percentages. The combined analysis indicated that the sole ammonium nitrate and (ammonium nitrate + ammonium sulphate) recorded the highest values of sugar recovery and the lowest values of sugar loss to molasses percentages compared to other forms. This result could be attributed to higher values of sucrose (Table 10), lower values of alpha-amino content.

Table (11): **Alpha-amino nitrogen content (meq/100 g beet)**, **sugar recovery and sugar loss to molasses percentages as affected by the sole and combined application of nitrogen sources and zinc fertilization levels in 2011/2012 and 2012/201 seasons and their combined.**

Nitrogen treatments	Alpha-aminoN (meq/100 g beet)		Comb.	Sugar recovery %		Comb.	Sugar loss to molasses %		Comb.
	1st season	2nd season		1st season	2nd season		1st season	2nd season	
Urea	2.23	2.30	2.26	12.90	12.84	12.87	2.48	2.49	2.49
A. nitrate	2.17	2.11	2.14	13.50	13.39	13.44	2.42	2.40	2.41
A. sulphate	2.19	2.26	2.22	13.13	13.06	13.10	2.51	2.49	2.50
Urea + AN	2.20	2.18	2.19	13.52	13.37	13.45	2.45	2.48	2.47
Urea+ AS	2.29	2.45	2.37	12.91	12.98	12.94	2.50	2.54	2.52
AN + AS	2.12	2.21	2.17	13.80	13.65	13.73	2.40	2.46	2.43
LSD	**NS**	**NS**	**0.08**	**0.21**	**0.24**	**0.12**	**0.06**	**0.05**	**0.02**
Without zinc	2.22	2.26	2.24	13.06	12.94	13.00	2.47	2.48	2.47
Zinc 2	2.18	2.24	2.21	13.27	13.23	13.25	2.46	2.48	2.47
Zinc 3	2.19	2.25	2.23	13.54	13.48	13.51	2.45	2.47	2.46
LSD	**NS**	**NS**	**NS**	**0.13**	**0.08**	**0.08**	**NS**	**NS**	**NS**

Urea : CO $(NH_2)_2$ containing 46.5 % N was applied as a sole.
A.N.: Ammonium nitrate NH_4 (NO_3) containing 33.5 % N was applied as a sole.
A.S.: Ammonium sulfate $(NH_4)_2SO_4$ containing 20.6 % N and 24 S%, was applied as a sole.
Without zinc (Control): Sugar beet plants were sprayed with water.
Zinc 1 : 1000 ppm zinc as foliar application in the form of zinc sulphate after thinning and one 75 days later.
Zinc 2 : 2000 ppm zinc as foliar application in the form of zinc sulphate after thinning and one 75 days later.

The data in the same table show that sugar recovery % revealed a significant response to zinc concentration over the check treatment in both season and their combined, while, none of the zinc concentration levels had a significant influence on sugar loss to molasses percentage and alpha–amino nitrogen content/beet in both seasons and their combined (**Mousavi**, ***et al***. **2011)**.

8. Juice quality percentage and recoverable sugar yield/fed:

The results in Table 12 declared that fertilizing sugar beet with ammonium nitrate solely and combined of ammonium nitrate + ammonium sulphate at 50:50 ratio recorded significantly higher juice quality% and recoverable sugar yield/fed than that fertilized with the other forms of individual or mixed ones. The combined analysis indicated that fertilizing sugar beet with the sole application of ammonium nitrate gave 0.96 and 0.80 increase in juice quality percentage and 0.18 ton/fed and 0.09 ton/fed increase in recoverable sugar yield over that fertilized with urea and ammonium sulphate solely, respectively. These results are in line with those reported by **Mousa (2004)** who observed that nitrogen fertilizer sources such as ammonium nitrate had a significant effect on the parameters of sugar beet and gave the highest values of juice quality percentage and recoverable sugar yield/fed. The mixture of ammonium nitrate + ammonium sulphate gave 0.45 and 1.25 increase in juice quality percentage and 0.10 ton/fed and 0.24 ton/fed increase in recoverable sugar yield over that fertilized with mixture of urea + AN and mixture of urea + AS, respectively. These results may be due to higher values of sucrose and lower, Na accumulation and improved K uptake in roots% (Table 10) as well as lower Cl content (Table 8).

Juice quality% and recoverable sugar yield/fed were appreciably increased by increasing the sprayed zinc levels in the 1st season and 2nd season and their combined. The combined analysis indicated that adding zinc at the rate of 2000 ppm gave (0.56 and 0.27) and (0.22 and 0.10 ton/fed) increase in juice quality percentage and recoverable sugar yield/fed, over that unfertilized (without zinc) and that fertilized with 1000 ppm zinc, respectivelly. These results assured the important role of zinc element as reported by **Mousavi**, ***et al***. **(2011)**.

Table (12): Juice quality percentage and recoverable sugar yield (ton/fed) as affected by the sole and combined application of nitrogen sources and zinc fertilization levels in 2011/2012 and 2012/2013 seasons and their combined.

Nitrogen treatments	Juice quality sugar %		Comb.	Recoverable sugar yield (ton/fed)		Comb.
	1st season	2nd season		1st season	2nd season	
Urea	83.87	83.75	83.81	2.56	2.54	2.55
A. nitrate	84.79	84.75	84.77	2.75	2.70	2.73
A. sulphate	83.96	83.97	83.97	2.65	2.62	2.64
Urea + AN	84.64	84.34	84.49	2.76	2.72	2.74
Urea+ AS	83.75	83.63	83.69	2.60	2.61	2.60
AN + AS	85.16	84.72	84.94	2.86	2.81	2.84
LSD	**0.33**	**0.48**	**0.18**	**0.05**	**0.06**	**0.02**
Without zinc	84.12	83.89	84.00	2.57	2.58	2.57
Zinc 1	84.33	84.20	84.27	2.71	2.67	2.69
Zinc 2	84.64	84.49	84.56	2.82	2.76	2.79
LSD	**0.17**	**0.12**	**0.13**	**0.03**	**0.02**	**0.02**

Urea : $CO(NH_2)_2$ containing 46.5 % N was applied as a sole
A.N.: Ammonium nitrate $NH_4(NO_3)$ containing 33.5 % N was applied as a sole
A.S.: Ammonium sulfate $(NH_4)_2SO_4$ containing 20.6 % N and 24 S%, was applied as a sole.
Without zinc (Control): Sugar beet plants were sprayed with water.
Zinc 1 : 1000 ppm zinc as foliar application in the form of zinc sulphate after thinning and one 75 days later.
Zinc 2 : 2000 ppm zinc as foliar application in the form of zinc sulphate after thinning and one 75 days later.

CONCLUSION

Under conditions of the present work, the periotity of fertilizing sugar beet with ammonium nitrate compared to fertilizing it with a ammonium sulphate or urea solely or by using a mixture of ammonium nitrate and ammonium sulphate at 50:50 ratio + 2000 ppm zinc as foliar application can be recommended to get the highest root and sugar yields/fed.

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تأثُر حاصل وجودة بنجر السكر بمصادر النيتروجين والتسميد بالزنك تحت ظروف الأراضي الملحية

صلاح علي عبد اللاه محمود عنان
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أقيمت تجربتان حقليتان فى تصميم قطع منشقة بمحطة بحوث السرو- محافظة دمياط (دائرة عرض ٣١.١٤ ° شمالاً وخط طول ٣١.٣٩ ° شرقاً) في موسمى ٢٠١٢/٢٠١١ و ٢٠١٣/٢٠١٢ لدراسة تأثير مصادر مختلفة من النيتروجين هي: ١- التسميد باليوريا منفردةٍ، ٢- التسميد بنترات الأمونيوم منفردةٍ، ٣- التسميد بكبريتات الأمونيوم منفردةٍ، ٤- التسميد بمخلوط من اليوريا ونترات الأمونيوم بنسبة ٥٠ :٥٠%، ٥- التسميد بمخلوط من اليوريا وكبريتات الأمونيوم بنسبة ٥٠ :٥٠%، ٦- التسميد بمخلوط من نترات الأمونيوم وكبريتات الأمونيوم بنسبة ٥٠ :٥٠%، وثلاث تركيزات من الزنك تم إضافتهم رشاً علي دفعتين (بعد الخف و بعد ٧٥ يوماً من الزراعة) هي:

١- الرش بالماء بدون زنك (مقارنةٍ).

٢- الرش بمحلول ١٠٠٠ جزء في المليون/زنك (كبريتات الزنك ٢٢% زنك).

٣- الرش بمحلول ٢٠٠٠ جزء في المليون/زنك (كبريتات الزنك ٢٢% زنك) على بعض صفات النمو وحاصل وجودة بنجر السكر.

أوضحت النتائج ما يلي:

١- أعطي التسميد النتروجيني في صورة نترات الأمونيوم منفردةٍ والتسميد النتروجيني كمخلوط من نترات الأمونيوم وكبريتات الأمونيوم بنسبة ٥٠ : ٥٠% زيادة معنوية في طول وقطر و وزن الجذر والأوراق ، وحاصل الجذور والأوراق والسكر/فدان، ومحتوي الأوراق من النيتروجين والماعنسيوم والكالسيوم والزنك والفوسفور والممتص من الزنك في الجذور فضلا عن النسبة المئوية للسكروز والجودة في الموسمين والتحليل التجميعي لهما.

٢- أعطي التسميد النتروجيني كمخلوط من نترات الأمونيوم وكبريتات الأمونيوم بنسبة ٥٠:٥٠% زيادة معنوية عن باقي الأسمدة النتروجينية المستخدمة سواء كانت منفردةٍ أو مخلوطة في كل الصفات فيما عدا محتوي الأوراق من الفوسفور والكالسيوم والممتص من الزنك في الجذور وجودة الجذور حيث لم يكن هناك فرق معنوي بين التسميد بنترات الأمونيوم منفردةٍ وبين التسميد في صورة مخلوط من نترات الأمونيوم وكبريتات الأمونيوم بنسبة ٥٠ : ٥٠%.

٣- دلت النتائج علي أن الرش بإضافة ٢٠٠٠ جزء في المليون/زنك قد نتج عنه زيادة معنوية في طول وقطر ووزن الجذر الطازج وحاصل الجذور والأوراق والسكر/فدان، فضلا عن محتوي الزنك في جذور وأوراق بنجر السكر.

٤- أظهر التفاعل بين مصادر النيتروجين ومستويات الزنك تأثيراً معنوياً علي الوزن الطازج للجذر والأوراق وحاصل الجذور/فدان في الموسمين، حيث أعطي التسميد النيتروجيني كمخلوط من نترات الأمونيوم وكبريتات الأمونيوم بنسبة ٥٠:٥٠ مع التسميد الورقي بإضافة ٢٠٠٠ جزء في المليون/زنك أعلي قيم للوزن الطازج للجذور والأوراق وحاصل الجذور/فدان مقارنةً بالمعاملات الأخري في الموسمين.

وعلي أساس نتائج هذا البحث فإنة يمكن التوصية بتسميد بنجر السكر المنزرع تحت ظروف التربة الملحية باستخدام نترات الأمونيوم مقارنةً بالتسميد بكبريتات الأمونيوم أو اليوريا عند التسميد المنفرد لأي منهما، أو التسميد بمخلوط من نترات الأمونيوم وكبريتات الأمونيوم بنسبة ٥٠:٥٠% مقارنةً بالتوليفات الأخرى مع التسميد الورقي بإضافة ٢٠٠٠ جزء في المليون/زنك.