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The effect of Zn (+) application on refined sugar yield, refined sugar content, root yield, sucrose content, K, Na and α-amino N contents of several sugar beet variety

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Abstract

The root yields changed between 105.66 t/ha (Lider) and 157.15 ton/ha (Libellule) while beet yields of sugar beet varieties belonged to control (without Zn application) group (Zn(-)) are established between 95.34 ton/ha (Lider) and 137.92 ton/ha (Libellule). The yield of beet varieties grown in Zn (+) applied soils increased compared to control. While the sucrose amounts of sugar beet varieties for control (Zn(-)) vary between 13.70% (Rodeo) and 13.86% (Libellule), the sucrose contents of beet varieties grown in Zinc applied leaf were identified between 15.23% (Rodeo) and 15.46% (Lider). K, Na and α-amino N results showed fluctuations depending on sugar beet varieties. There were statistically significant differences among K, Na and α-amino N contents of sugar beet varieties ($p<0.01$; $p<0.05$) depending on Zn (+) application compared to control (Zn (-)) groups. The refined sugar yield is directly related to the refined sugar content and sugar beet yield.

Keywords: Beet, Zn application, sugar contents, root yields, α-amino N

1. Introduction

Sugar beet (*Beta vulgaris* L.) is one of the world's most important industrial plant. Recent research has shown that the lack of sufficient micronutrients in the soil results in the production of low nutritional value agricultural products that contribute to poorer nutrition and health for both crops and humans [1]. *Fathy et al.* [2] found that the photosynthetic pigment content was found higher by applying zinc from the leaves to sugar beet compared to control. It was determined that Zn application by spraying increased Fe, Zn, manganese (Mn) and Cu concentrations in wheat grains and straw [3]. Zinc deficiency prevents the normal growth of the plant and causes a significant loss in vegetative production. The main factors hindering zinc uptake are: higher soil pH levels with higher lime and clay content, higher application of phosphorus and lower soil temperature [4,5]. For the biological processes of many plants, zinc must be present in the environment [6,7].

It has been reported that zinc deficiency appears to be the most common and common micronutrient deficiency problem in crop plants worldwide, resulting in serious losses in yield and nutritional quality [8]. Zinc is considered as an essential micronutrient and an element that has certain physiological functions in all living systems [9]. Recently, zinc deficiency has become a major problem in soils that contain small amounts of zinc and have higher pH, lime and clay, and less organic matter. The reasons for this are probably the use of high-yielding varieties, intensive farming, decrease in zinc-containing fungicide applications, increased use of phosphorus fertilizers, and restriction of industrial wastes with high zinc content [10-12]. The aim of current study was to investigate the effect of Zn(+) on refined sugar yield, refined sugar content, root yield, sucrose content, K, Na and α-amino N contents of roots of several suger beet varieties (Lider, Rodeo and Libellule).

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2. Materials and Methods:

2.1.Experimental design

The trial was established and carried out in four replications, according to the 2-factor trial pattern, in the agricultural R&D trial field of the Çumra Sugar Integrated Facilities nursery field in the Çumra District of Konya Sugar Industry. The experiment consisted of 3 sugar beet varieties (Leader, Rodeo, Libellule) X 2 Zn (present or not) application dose X 4 repetitions = 24 plots. The parcel size has been taken as 15 m^2 (1.5 x 10 m).

2.2.Soil properties

The soil of the trial area, which has clay-loam structure, contains 2.47% organic matter and 25.8% more lime, its pH is slightly alkaline (7.95) and does not contain salt that will adversely affect plant growth. According to Olsen's $NaHCO_3$ method, 83 ppm of phosphorus was found in the soil of the trial area; The amounts of Ca, Mg, K and Na extractable with 1N CH_3COONH_4 were 8.1, 2.3, 7.6 and 0.23 me / 100g, respectively; The extractable amounts of Fe, Mn and Cu with DTPA solution were determined as 13.1, 4.1 and 1.4 ppm, respectively, and the amount of zinc extractable with DTPA solution of the soil is 1.16 ppm and is sufficient [13].

2.3.Appliactions

After the soil in the experimental area was made ready for planting, 8 kg N, 18 kg P_2O_5 and 12 kg K_2O (in the form of 8.18.15 compound fertilizer) were sprinkled and mixed in all plots per decare. Later, 6 kg N per decare was given in the third tillage period and 5 kg N before the second water (in the form of urea fertilizer), and 20 kg N per decare was given before planting. In the experiment, two different zinc doses (control; 0.3% Zn / da) were applied as foliar application in the form of zinc sulphate. During the trial, 1/3 of the zinc was applied in the first soil cultivation in May, in leaf 1/3 in July and 1/3 in the end of August. 0.3% zinc sulfate solution was applied by spraying the beet leaves in each parcel. In the third week of April, 28 g (2.1 kg seed / da) seeds were planted manually from the S - 814 monogerm seed varieties, which are Lider, Rodeo and Libellule, with a row spacing of 45 cm and an 8 cm row. After the beet seeds started to germinate (approximately one month after planting), thinning and dilution process was carried out so that the row was 22 cm. 122 plants (9000 plants / da) were left in all parcels. The third tillage was carried out approximately 16 days after the tillage in the singling stage. A total of 10 irrigations were made, with the first irrigation on May 25. A total of 10 irrigations were made, with the first irrigation on May 25.

2.4.Harvest

Sugar beets, which completed their vegetation period and reached physiological maturity, were harvested by manuel system equipment at the end of October. In order to obtain the harvest results in a healthy way, 80 beets were harvested in an area of 7.40 x 1.35 (3 rows) = 10 m^2 by laying 2.3 m from the plot heads and a row from the edges. After cutting the heads and leaves of the harvested beets, they were brought to the Konya Sugar Factory laboratory.

2.5.Calculations of parameters

Beet yield was determined by weighing the beets washed with pressurized water before chopping for quality analysis. Root sugar content (RSC) was determined by Reinefeld [14] and refined sugar content (RSC) and refined sugar yield (RSY) per decare with the help of the following equations [15]:

Refined sugar content (%) = Sugar content- [0,343 (Na+K)+0,094 amino-N+0,29]

Refined sugar yield (t/ha) = Root yield x % Refined sugar content / 100

2.6. Statistically analysis

The statistical analysis of the data obtained was made through the JMP statistical program (JMP, SAS Institute, Cary, NC) [16].

3.Results and Discussion

The sugar beet yields of beet varieties applied Zn are given in Table 1. Zn (+) application showed differences in sugar beet yields depending on varieties. The root yields changed between 105.66 t/ha (Lider) and 157.15 ton/ha (Libellule) while beet yields of sugar beet varieties belonged to control (without Zn application) group (Zn(-)) are established between 95.34 ton/ha (Lider) and 137.92 ton/ha (Libellule). The yield of beet varieties grown in Zn (+) applied leafs increased compared to control. The most increase was detected in Libellule variety. The yield increase in beets was from the highest to the lowest as follows: Libellule > Rodeo > Lider.

The sucrose contents and refined sugar content of sugar beet varieties treated Zn (+) are illustrated in Table 2. While the sucrose amounts of suger beet varieties for control (Zn(-)) vary between 13.70% (Rodeo) and 13.86% (Libellule), the sucrose contents of beet varieties grown in Zinc applied leaf were identified between 15.23% (Rodeo) and 15.46% (Lider). In addition, while refined sugar content of beet samples belonged to control are identified between 9.59% (Rodeo) and 10.07% (Lider), the refined sugar content of sugar beet varieties changed between 10.45% (Libellule) and 10.83% (Rodeo). As seen in Table 2, the lowest sugar was determined in Rodeo beet variety. Also, the lowest purified sugar content was detected in Libellule beet cultivar grown in zinc (+) treated leaf. In addition, the highest sugar content was measured in the Lider beet variety in zinc applied leaf.

The K, Na, and α-amino N amounts of sugar beet varieties grown in Zn applied leaf are presented in Table 3. K, Na and α-amino N results showed fluctuations depending on sugar beet varieties. There were statistically significant differences among K, Na and α-amino N contents of sugar beet varieties ($p<0.01$; $p<0.05$) depending on Zn (+) application compared to control (Zn (-)) groups. While K contents of sugar beets belonged to control vary between 7.28 mmol/100g (Lider) and 8.29 mmol/100g (Libellule), K amounts of beet samples were found between 8.38 mmol/100g (Rodeo) and 9.75 mmol/100g (Lider). In addition, Na amounts of sugar beet samples grown in leaf without Zn (control) were determined between 0.88 mmol/100g (Lider9 and 1.00 mmol/100g (Libellule) while Na contents of beets grown in Zn (+) treated leaf are found between 1.02 mmol/100g (Rodeo) and 1.24 mmol/100g (Lider). Also, α-amino N contents of sugar beet samples grown in control and zinc applied leafs varied between 6.03 mmol/100g (Libellule) and 8.21 mmol/100g (Rodeo) to 8.71 mmol/100g (Lider). As a result of the application of zinc to the leaf, the amount of K, Na and α-amino N in beet roots did not increase too much, showing a positive result. Particularly nitrogenous compounds reveal negative properties such as foaming in the processing of beet into sugar. The highest K and Na contents were detected in the Lider beet variety grown in zinc treated leaf.

The refined sugar yield of sugar beet varieties grown in Zn treated soil are shown in Table 4. The refined sugar yield values showed differences depending on Zn applications.

While refined sugar yield values of control (Zn (-)) samples change between 9.63 ton/ha (Lider) and 13.49 ton/ha (Libellule), the refined sugar yields od sugar beet samples grown in Zn treated leaf were determined between 11.19 ton/ha (Lider) and 16.40 ton/ha (Libellule). There were statistically significant differences among the amounts of refined sugar yields depending on beet varieties ($p<0.01$). The highest refined sugar yields were detected in Libellule beet variety grown in both control and zinc applied leafs. The refined sugar yield is directly related to the refined sugar content and sugar beet yield. The high sugar beet yield and the high refined sugar amounts lead to the increase the refined sugar yield. Productivity of sugar yield significantly increased by cultivation beet and Zn application. The increase in root yield/fed may be due to the increase in root length, root diameter and root weight/plant. The above mentioned results are in partly differences with those obtained by Taha et al. [17], Piskin [18] and *Zewail et al*. [1]. The role of micronutrients an increasing dry matter and root yield in sugar beet was reported by *Abd El-Gawad et al*. [19], *Yarnia et al.* [20], *Nemeat-Alla et al*. [21] and *Amin et al*. [22]. A total of 5 kg/ha zinc application on sugar beet significantly increased the yield and quality of sugar beet; the rate of increase was in the range of 4.62-6.97% in root yield, 2.09-5.75% in sugar percentage, 2.60-8.03% in white sugar percentage and 7.84-13.06% in white sugar yield [18]. *Piskin* [18] reported that root yield, sugar percentage, alpha-amino N, potassium, Na concentration, white sugar percentage and white sugar yield values of sugar beet under field conditions in response to applications of zinc changed between 67.91 and 72.64 kg/ton, 16.73 and 17.43% sugar, 1.96 and 2.11 mmol/100g K, 3.64 and 3.72 mmol/100g, 1.90 and 2.09 mmol/100g, 14.31 and 14.99% and 9.72 and 10.89 ton/ha. *Piskin and Inal* (2014) [18], as a result of the study in which they investigated the effects of increasing nitrogen applications (10, 13, 16, 19 and 21 kg N / da) on the yield and quality of sugar beet, the nitrogen application increased the amount of amino nitrogen, sodium and potassium, They reported the amount of 6.67, 1.67 and 5.16 mmol / 100 g in the root with high dose nitrogen application (21 kg N da^{-1}), respectively [30]. Previously made zinc applications increased the yield and quality values of sugar beet very little [23] or not at all [24,25]. It is considered that the physical and chemical properties of the soil of the research plots and lower level of available zinc concentration increase the positive reaction of sugar beet to the applied zinc. *Masri and Hamza* [9] reported that the mixture of micronutrients was applied at these different concentrations (Zn+Mn+B) in ppm, as well as the control treatment of distilled water, and the results revealed that increasing micronutrients mixture from Co (control) level up to C3 level significantly increased root weight by 21.54% and 23.81%, root yield by 28.00% and 24.40% and sugar yield by 76.50% and 60.61% in the first and second session, respectively. *Aktaş et al*. [26] reported that Zn and B are essential micronutrients required for optimum growth and yield of sugar beet and in more soluble and diffusible composition would be more productive. *Zewail et al*. [1] setermined 23.29 and 22.84% sucrose, 17.59 and 16.91 ton/ha sugar yield, 75.80 and 73.47 ton/ha root yield at 100g/L zinc applications for 2017 and 2018 harvest times, respectively. *Moustafa* [27] studied the effect of sowing dates on yield, yield component and quality of sugar beet during 2015/2016 and 2016/2017 seasons, and they found 1906.77 and 1650 g/plant to 1956.67 and 1766.67 g/plant root weight, 18.93 and 18.08 to 18.33 and 17.48% sucrose, 19.91 and 17.59 to 20.60 and 18.23 ton/fed root yield, respectively. *Abd El-Gawad et al*. [19], *Yarnia et al*. [20] and *Nemeat-Alla et al*. [21] reported that application of high rates of micronutrients produced the highest root yield of sugar beet plants, while it produced the lowest values of quality characters such as sucrose. *Mousavi et al.* [28] reported that crop yield significantly increases with the use of micronutrients such as Zn, Fe, B and Mn that have an important metabolic role in plant growth and development therefore called an essential trace elements or a micronutrients. Also, Zn has a positive impact on crops yield; therefore crops quantitative and qualitative yield is strongly dependent on zinc [28]. The Zn treatment has a beneficial role in various biochemical processes through nutrient uptake and maintaining phytohormones, vitamins, and amino acids level in the plant tissues, increasing root and shoot growth on a fresh and dry weight basis on the enhancement of plant root uptake of phosphorus (P), potassium (K), iron (Fe), copper (Cu), zinc (Zn) and calcium (Ca) [29]. Results showed some fluctuations compared to literature values. These fluctuations can be due to soil structure, beet variety, treated Zn amounts, plant growth stage, genetic, climatic factors, analytical conditions and locations.

Table 1. The effect of Zn applications on beet varieties' root yields

	Yield, ton/ha		
Variety/Appliacation	**Zn (-)**	**Zn (+)**	**Mean**
Lider	95.34±6.70	105.66±6.80	**100.50 c**
Rodeo	125.45±6.30	135.91±7.35	**130.68 b**
Libellule	137.92±10.18	157.15±14.38	**147.53 a**
Mean	**119.57 B**	**132.91 A**	**-**

$p<0.01$

Table 2. The effect of Zn applications on sugar content and refined sugar content of beet varieties

Variety/Application	**Sugar contents (%)**			**Refined sugar content (%)**		
	Zn (-)	**Zn (+)**	**Mean**	**Zn (-)**	**Zn (+)**	**Mean**
Lider	13.78±0.22	15.46±0.86	**14.62**	10.07±0.63	10.58±0.53	**10.32**
Rodeo	13.70±0.20	15.23±0.66	**14.46**	9.59±0.73	10.83±1.21	**10.21**
Libellule	13.86±0.63	15.34±0.51	**14.60**	9.81±0.82	10.45±0.38	**10.13**
Mean	**13.78 B**	**15.34 A**	-	**9.82 B**	**10.62 A**	-

$p<0.01$, $p<0.05$

Table 3. The effect of Zn applications on K, Na and α-amin N of beet varieties

Variety/Application	K (mmol/100g)			Na (mmol/100g)			α-Amino N (mmol/100g)		
	Zn (-)	Zn (+)	Mean	Zn (-)	Zn (+)	Mean	Zn (-)	Zn (+)	Mean
Lider	7.28±1.56	9.75±0.59	**8.52**	0.88±0.16	1.24±0.29	**1.06**	6.63±1.04	8.71±1.28	**7.67 b**
Rodeo	7.97±1.67	8.38±1.95	**8.17**	0.93±0.15	1.02±0.30	**0.97**	8.21±1.54	9.42±1.12	**8.82 a**
Libellule	8.29±0.72	9.74±0.44	**9.02**	1.00±0.14	1.21±0.19	**1.10**	6.03±0.97	8.92±1.32	**7.48 b**
Mean	**7.85 B**	**9.29 A**	-	**0.93 B**	**1.15 A**	-	**6.96 B**	**9.02 A**	-

$p<0.01$, $p<0.05$

Table 4. The effect of Zn applications on refined sugar yield of beet varieties

Variety/Application	Refined sugar yield (ton/ha)		
	Zn (-)	Zn (+)	Mean
Lider	9.63±1.26	11.19±0.10	**10.41 c**
Rodeo	12.00±0.47	14.72±0.18	**13.36 b**
Libellule	13.49±0.95	16.40±0.12	**14.95 a**
Mean	**11.71 B**	**14.10 A**	-

$p<0.01$

5. Conclusion

The most increase was detected in Libellule variety. The yield increase in beets was from the highest to the lowest as follows: Libellule > Rodeo > Lider. The lowest purified sugar content was detected in Lubellule beet cultivar grown in zinc (+) treated leaf. In addition, the highest sugar content was measured in the Lider beet variety in zinc applied leaf. K, Na and α-amino N results showed fluctuations depending on sugar beet varieties. The highest K and Na contents were detected in the Lider beet variety grown in zinc treated leaf. The highest refined sugar yields were detected in Libellule beet variety grown in both control and zinc applied leaves. The refined sugar yield is directly related to the refined sugar content and sugar beet yield.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human or animal subjects (if exist) respect the specific regulation and standards.

References

1. Zewail, R.M.Y., El-Gmal, I.S., Khaitov, B., El-Desouky, H.S.A. (2020). Micronutrients through foliar application enhance growth, yield and quality of sugar beet (*Beta vulgaris* L.). *J. Plant Nutr.*, **2020**, *43*, 15, 2275-2285, https://doi.org/10.1080/01904167.2020.1771580
2. Fathy, M.F., Abd EL-Motagally, A., Attia, K.K. (2009). Response of sugar beet plants to nitrogen and potassium fertilization in sandy calcareous soil. *Int. J. Agric. Biol.* **2009**, *11*, 695–700.
3. El-Naggar, E.M., El-Ghamry, A.M., Effect of bio and chemical nitrogen fertilizer with foliar of humic and amino acid on wheat. *J. Agric. Sci.* **2007**, *32*(5), 4029–43.
4. Lindsay, W.L., Zinc in soils and plant nutrition. *Advances in Agronomy* **1972**, *24*, 147–86, https://doi.org/10.1016/S0065-2113(08)60635-5
5. Marschner, H., Zinc in soils and plants. *Developments in Plant Soil Sci.* **1993**, *55*, 59–77.
6. Neamatollahi, E., Khademosharieh, M.M., Darban, A.S., Jahansuz, M.R. (2013).Application of different amounts of $ZnSO_4$ in five varieties of sugar beet. *Advances Environl. Biol.* **2013**, *7*(6), 1113-1116.
7. Gobarah, M.E., Tawfik, M.M., Zaghloul, S.M., Amin, G.A. (2014). Effect of combined application of different micronutrients on productivity and quality of sugar beet plants (*Beta vulgaris* L.). *Int. J. Plant Soil Sci.* **2014**, *3*, 589-598. DOI: 10.9734/IJPSS/2014/8193
8. Kobraee, S., Mohamadi, G.N., Heidari, S.H., Kajori, F.D., Delkhosh, B., Influence of micronutrient fertilizer on soybean nutrient composition. *Indian J. Sci. Technol.*, **2011**, *4*(7), 763-769, DOI: 10.17485/ijst/2011/v4i7/30107
9. Masri, M.I., Hamza, M.**,** Influence of foliar application with micronutrients on productivity of three sugar beet cultivars under drip irrigation in sandy soils. *World J. Agric. Sci.* **2015**, *11*(2), 55-61, DOI: 10.5829/idosi.wjas.2015.11.2.1846
10. Bakhsh Kelarestaghi, K., Khalili, A., Ahmadi, G., *Effect of micro nutrients on sugar beet in Djovain area of Iran.* Paper presented at Institute International de Recherches Betteravieres Proceedings, 389–95. Brussels, Belgium, **2002**, February 13-14.

11. Stevens, W.B., Mesbah, A.O., Zinc sulfate applied to sugarbeet using broadcast, seed-placed and foliar methods. *Paper presented at Western Nutrient Management Conference 6*, Salt Lake City, UT, **2005**, March 3–4.
12. Grieve, C.M., Grattan, S.R., Maas, E.V., Plant salt tolerance. In: W.W. Wallender and K.K. Tanji (eds.) ASCE Manual and Reports on Engineering Practice No. 71 *Agricultural Salinity Assessment and Management* (2nd Edition). ASCE, Reston, VA. Chapter 13, **2012**, 405-459.
13. Sillanpaa, M. Micronutrients and the nutrients status of soils. *A Global Study. Fao Soils Bull* No: 4843-93, **1982**.
14. Reinefeld, E.,, Emmerich, A., Baumgarten, G., Winner, C., Beiss, U., Prediction of molasses sugar from beet analysis. Zucker, **1974**, *27*, 2–15.
15. Kubadinow, N., Wienninger, L., Compt. Rent. X›v, Ass. Comm. Int. Teach. Sucr. (C›ts) Brussel, **1971**, 539: S.A. Zucker 25, 43.
16. Savaşlı, E., Önder, O., Karaduman, Y., Dayıoğlu, R., Özen, D., Özdemir, S., Akın, A., Tunca, Z.S., Demir, B., Aydın, N., The effect of soil and foliar ürea application at heading stage on grain yield and quality traits of bread wheat (*Triticium aestivum* L.). *Turkish J. Agric. Sci. Tech.* **2019**, *7*, 1928-1936.
17. Taha, E.M., El-Ashmony, M.S., El-Sherbeny, A.A.. The influence of sowing dates and varieties on yield of sugar beet. *El-Minia J. Agric. Res. Develop*. **1985**, *7*(2), 737-748.
18. Piskin, A., Effect of Zinc applied together with compound fertilizer on yield and quality of sugar beet (*Beta vulgaris* L.). *J. Plant Nutr*., **2017**, *40*, 2521-2531, https://doi.org/10.1080/01904167.2017.1380815
19. Abd El-Gawad, A.M., Allam, S.A.H., Saif, L.M.A., Osman, A.M.H., Effect of some micronutrients on yield and quality of sugar beet (*Beta vulgaris* L.) juice quality and chemical composition. *Egypt. J. Agric. Res.*, **2004**, *82*(4), 1681-1701.
20. Yarnia, M., Benam, M.B.K., Arbat, H.K., Tabrizi, E.F.M., Hssanpanah, D., Effects of complete micronutrients and their application method on root yield and sugar content of sugar beet cv. Rassoul. *J. Food, Agric. Environ*., **2008**, *6*(3&4), 341-345.
21. Nemeat-Alla, E.A.E., Zalat, S.S., Bader, A.I., Sugar beet yield and quality as affected by nitrogen levels and foliar application with micronutrients. *J. Agric. Res. Kafr El-Sheikh Univ. Egypt*, **2009**, *35*(4), 995-1012.
22. Amin, G.A., Badr, E.A., Afifi, M.H.M., Root yield and quality of sugar beet (*Beta vulgaris* L.) in response to bio fertilizer and foliar application with micro-nutrients. *World Applied Sci. J.*, **2013**, *27*(11),1385-1389, ISSN 1818-4952
23. Boawn, L.C., Jr. Viets, F.G., Nelson, C.E., Crawford, C.L. (1961).Yield and zinc content of sugar beets as affected by nitrogen source, rate of nitrogen and zinc application. *J. Am. Soc. Sugar Beet Technol.* **1961**, *11*, 279–86.
24. Judy, W., Melton, J., Lessman,G., Ellis, B., Davis, J., Zinc fertilization of pea beans, corn and sugar beets in 1964. In: *Agricultural experiment station research report* **1964**, *33*, 1–8. East Lansing, Michigan: Michigan State University.
25. Lamb, J.A., Cattanach, A.W., Zinc application on sugarbeet. In 1989 Sugarbeet research and extension reports. The Sugarbeet Research and Education Board of Minnesota and North Dakota 20, 84–6. Fargo, North Dakota: North Dakota State University, **1990**
26. Aktas, H., Abak, K., Ozturk, L., Cakmak, S., The effect of Zn on growth and shoot concentrations of sodium and potassium in pepper plants under salinity stress. *Turkish J. Agric. Forest*. **2006**, *30*, 407–12.
27. Moustafa, M.S.A., Influence of sowing dates and foliar spraying of iron and zinc on sugar beet productivity in salt affected soil. *J. Plant Production, Mansoura Univ.*, **2019**, *10*(7), 569-573. DOI: 10.21608/jpp.2019.53554
28. Mousavi, S.R., Galavi, M., Rezaei, M., Zinc (Zn) importance for crop production - A Review. *Int. J. Agron. Plant Product*., **2013**, *4*(1), 64-68.
29. Leite, C.M., da Silva, A., Cesar, F.R., Guimaraes, G.G., Almeida, E., Muraoka, T., Low efficiency of Zn uptake and translocation in plants provide poor micronutrient enrichment in rice and soybean grains. *J. Plant Nutr.*, **2020**, *43*(1),79–91. https://doi.org/10.1080/01904167.2019.1659341
30. Piskin, A., Inal, A., The effet of nitrogen on yield and quality of sugar beet in drip irrigation. *Atatürk Univ. J. Agric. Fac*., **2014**, *45*(1), 21-29.