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RESPONSE OF SUGAR BEET GROWN IN CALCAREOUS SOIL TO IRON AND MANGANESE

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Abstract

A field experiment was conducted in a calcareous soil, poor in available DTPA extracted Fe (6.27 ppm) and Mn (5.36 ppm), at Noubaria Reseasch staion Farm to investigate the effect of spraying with Fe (50 or 100 ppm Fe as FeSO4 or Fe-EDDHA) and /or Mn (50ppm Mn as $MnSO_4$) on root yield, root dry weight, nutrients uptake of N, P, K, Fe, Mn and Zn, total carbohydrate, and total soluble solids (T.S.S.) in sugar beet roots. The results emphasized that the amount of root yield, root dry matter and nutrients uptake were significantly higher in the combined treatment (Fe x Mn) than the other treatments and reached a maximum with Fe-chelated form. Little increase in carbohydrates was found by Fe and/or Mn addition. The interaction effect of Mn and Fe was significant in raising T.S.S. (T/fed.).

INTRODUCTION

Plant feeding through foliar application in calcareous soils is widely considered the reasonable technique especially for micronutrients which face shortage and/or less avaialbility (Kerolous *et al.*, 1998). As for iron, the indirect effect was the subject of many studies on sugar beet. Monged *et al.* (1993) found that 3% spray solution of Fe+B resulted in the highest root and sugar yield. In calcareous soil, Palanivel *et al.* (1993) reported that spraying 1.5% FeSO4/ha twice a month gave 11.5% increase of sugar cane yield than control. Nedunchzhizn *et al.* (1995) pointed out that sufficient iron in sugar beet leaves increased the whole chain of electron transfer and, consequently, increased contents of some polypeptides compared with Fe-deficient leaves. As for manganese, Koppen and Rostock (1991) reported that with increasing soil pH, soil nutrient contents decreased in the order Mn>Cu>B and sugar beet production decreased as a result. The experiment applied by Hassanin and Abuldahab (1991) found that 0.4% Mn foliar spray increased sugar and root yields compared with control. Toma *et al.* (1991) showed that Mn plays the role of an enzyme activator in sugar beet and has an important role in carbohydrate formation.

The objective of this study is to find out the suitable treatment of Fe with and without Mn combiation for root production in sugar beet and study some nutrient uptake by sugar beet root.

MATERIALS AND METHODS

The field experiment was conducted at Noubaria Agricultural Research Station Farm. A composite soil sample was collected from 0-30 and 30-60cm soil depths to determine some physical and chemical characteristics using standard methods according to Black *et al.*(1982).

Available Fe and Mn were determined in DTPA extract as described by Lindsay and Norvell (1978). The data are shown in Table 1.

The experiment was designed in a split plot design with four replicates. Plots of $3.5x6m^2$ area were planted with seeds of sugar beet (cv. Tribel morocpoly). After three weeks from planting, the seedlings were thinned to one for each hole. The plants were fertilized with 23, 67 and 20 kg/feddan of N,P and K as urea, calcium superphosphate and potassium sulphate, respectively. The fertilizers P and K were added after thinning and N was added after 6 weeks from cultivation. The spray treatments were as follows: the main plots were sprayed with five iron treatments; control (A), 50 ppm Fe as $FeSO_4$ (B), 100 ppm Fe as $FeSO_4$ (C), 50 ppm Fe as EDDHA-Fe (D) and 100 ppm Fe as EDDHA-Fe (E); Manganese was added as $MnSO_4$ 50ppm (I) or without Mn (O) corresponding the submain plots. Spray was repeated three times; 6, 9 and 12 weeks after planting with 2 liter/plot. The local agricultural practices were done during the growing season.

The roots were harvested after 30 weeks from cultivation; fresh and oven dry weights were recorded. Dried samples were cut into small portions, ground and prepared for analyses of N, P, K, Fe, Mn and Zn according to Chapman and Pratt (1961). Another part of dried samples was extracted with $1NH_2SO_4$ and 10% Ethanol to determine total carbohydrates and total soluble solids (T.S.S.) colorimitrically as described by AOAC (1970).

Statistical analysis of data was achieved according to Snedecor and Cochran (1971). Analyses of variance, correlation and regression were calculated using M-stat computer program.

Table 1. Texture and some physical and chemical properties of the experimental soil.

Depth (cm.)	% Without Ca CO_3 removal				Texture class	Ca CO_3 fraction (g/100g soil)			
	C.sand	F.sand	Silt	Clay		C.sand	F.sand	Silt-Clay	Total
0-30	12.1	40.4	15.0	32.5	Sand clay loam	3.9	6.3	15.5	25.7
30-60	10.3	35.2	14.4	40.1	sandy clay	4.4	5.1	19.5	29.0

Depth (cm.)	T.S.S. %	Anions me/100g soil				Cations me/100g soil			
		$CO_3^{=}$	HCO_3^-	$C1^-$	$SO_4^{=}$	ca^{++}	Mg^{++}	Na^+	k^+
0-30	0.30	-	0.64	6.12	2.61	2.60	1.20	5.32	0.25
30-60	0.25	-	0.72	5.80	1.29	2.56	0.62	4.43	0.20

Depth (cm.)	WHC %	F.C. %	CEC me/100g soil	pH (1:2.5) susp.)	O.M. %	Total N%	C/N	Available	
								Fe (ppm)	Mn(ppm)
0-30	49.8	28.7	22.64	8.0	0.68	0.042	16.2	6.34	5.42
30-60	62.5	36.0	25.47	8.2	0.59	0.004	14.8	6.19	5.29

RESULTS AND DISCUSSION

Root yield and root dry weight :

Data of Table 2 revealed that values of root yield and root dry weight of sugar beet ranged between 23.04 and 32.10 ton/fed and from 111.03 to 160.33 g/plant, respectively.

Table 2. Effect of Fe and Mn treatments on root yield (0: without, 1: with Mn).

Items & Unites	Mn treat.	Fe treatments A	B	C	D	E	mean	L.S.D at 0.05
Root yield ton/fed	O	23.04	24.20	25.44	28.87	32.05	26.72	Fe: 5.08*
	I	28.93	29.18	29.36	31.66	32.10	30.25	Mn: 8.24
	mean	25.99	26.69	27.40	30.26	32.07	28.49	Fex Mn: 7.18*
Root DW g/plant	O	110.80	114.17	119.14	114.64	160.37	122.82	Fe: 30.79*
	I	111.26	125.26	124.82	130.94	151.08	128.69	Mn: 46.26
	mean	111.03	119.76	121.98	122.79	155.72	126.26	FexMn:43.54

As for root yield, spraying with 100 ppm chelated Fe resulted in the highest yield with significant difference between it and each of control and 50 ppm mineral Fe. The other treatments gave the same effect. The values of root yield in case of Mn treatments did not reach the significant level over those without Mn. The interaction treatments (Fe x Mn) gave higher root yield values than those of Fe alone and reached maximum with Fe chelated. The same effect was shown in root dry weight per plant. It seems that Mn activated uptake of EDDHA-Fe even at the low level.

Nutrient uptake :

Values of nutrient uptake in beet roots are presented in Table 3. The amounts of N, P, and K absorbed were proportionally affected by Fe and/or Mn application. The response to Mn addition was not significant as with Fe. Uptake reached its maximum with the 100 ppm chelated Fe treatment either alone or combined with Mn.

Iron absorbed by roots significantly increased over the control when 100 ppm Fe mineral or chelated was applied. Data also revealed that Mn treatments raised the absorbed amount of Fe when it was mixed any Fe level with the maximum absorption in 100 ppm chelated Fe treatment (126.6 mg Fe/plant). Manganese uptake by sugar beet roots was significantly affected with Fe and/or Mn spray. Maximum values of Mn uptake were reported in the 100 ppm Fe chelated form treatments, either alone or combined with Mn. The values were 10.92 and 12.21mg Mn/plant, respectively. Concerning Zn content in beet root, the highest uptake appeared in 100 ppm Fe treatment alone or combined with Mn which may be due to Mn effect in activations of Zn uptake.

Table 3. Effect of Fe and Mn treatments on nutrients uptake (mg/plant) of sugar beet root (o: without, 1 : with Mn).

Treatments	Nitrogen	Phosphorus	Potassium	Iron	Manganese	Zinc
Mn O	1354	273	2132	80.4	7.37	10.39
I	1574	293	2328	95.6	9.59	11.26
L.S.D.	338	108	663	20.7	1.13*	3.68
Fe A	1216	258	1860	57.2	7.22	8.89
B	1409	284	2021	82.0	7.81	10.78
C	1419	276	2128	92.1	8.11	10.75
D	1441	285	2226	87.7	8.35	10.40
E	1836	314	2917	116.1	10.92	13.32
L.S.D.	347*	72	531*	20.7*	1.91*	2.77*
Fe A	1130	245	1817	51.0	6.65	6.65
B	1313	277	1872	73.1	6.85	10.27
Mno C	1278	2.75	2009	85.6	6.85	10.27
D	1284	280	2029	76.8	6.88	10.32
E	1764	290	2935	115.5	9.62	12.21
Fe A	1302	271	1903	63.4	7.79	11.13
B	1504	290	2169	90.9	8.77	11.28
Mn1 C	1560	276	2247	98.6	9.36	11.23
D	1597	289	2422	98.6	9.82	10.47
E	1907	337	2899	126.6	12.21	14.43
L.S.D.	490*	102	752*	30.1*	2.70*	3.91*

* Significant at 0.05 level

Multiple linear regression analyses were calculated to evaluate the relationships between root dry matter and nutrients uptake and the following equations were established:

	R
$\hat{y} = 48.19 - 0.0076x_1 - 0.00689x_2 + 0.0487x_3$	0.99**
$\hat{y} = 73.63 + 0.7197\bar{x}_1 + 1.1801\bar{x}_2 - 1.9152\bar{x}_3$	0.97**

Where:

$\hat{y}$ = Root dry weight (g/plant)
x1 = N (1907 - 1130 mg/plant)
x2 = P (337-245 mg/plant)
x3 = K (2935 - 1017 mg/plant)
x-1 = Fe (126.6-51.0 mg/plant)
x-2 = Mn (12.21 - 6.65 mg/plant)
x-3 = Zn (14.43 - 6.65 mg/plant)
R = Multiple correlation

$R_{4,6}$ at 0.05 = 0.94
0.01 = 0.97

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إستجابة بنجر السكر النامى فى أرض جيرية للرش بالحديد والمنجنيز

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أجريت تجربة حقلية بأرض جيرية تابعة لمحطة البحوث الزراعية بالنوبارية وتعانى من قلة الميسر من الحديد (٦,٢٧)، والمنجنيز (٥,٣٦) المستخلصين بمحلول ثنائى ايثيلين ثلاثى أمين خماسى حامض الخليك بها لبيان تأثير الرش بالحديد والمنجنيز كل على حدة أو مجتمعين على محصول بنجر السكر والوزن الجاف للجذر وبعض المغذيات الممتصة (ن ، فو ، بو، ح ، من ، خ) والكربوهيدرات الكلية وكذلك المواد الصلبة الذائبة الكلية فى جذور البنجر، وقد أضيف الحديد بتركيزات ٥٠ ، ١٠٠ جزء فى المليون بالصورة المعدنية أو المخلبية، أما المنجنيز فأضيف بالصورة المعدنية بتركيز ٥٠ جزء فى المليون.

وقد دلت النتائج على أن محصول الجذور (طن / فدان) والمادة الجافة بالجذر (جم/ نبات) والمغذيات الممتصة (مجم /نبات) تزداد باضافة المعاملات السابقة وتصل أعلاها فى معاملة الحديد المخلبى مع وجود المنجنيز حيث تكون معنوية عن المعاملات الأخرى، ومن جهة ثانية تزداد الكمية الكلية من الكربوهيدرات (طن/فدان) زيادة بسيطة بواسطة اضافة معاملات الحديد والمنجنيز ولكن بدون أى فرق معنوى عن المعاملات الأخرى وقد كان للتأثير المتبادل للحديد المخلبى والمنجنيز أكبر الأثر فى زيادة المحتوى الكلى من المواد الصلبة الذائبة (طن /فدان) حيث كانت الزيادة معنوية عن المعاملات الأخرى.