Egypt. J. Soil. Sci. **48**, No. 1, pp.17- 29 (2008)

Effect of Zn and B Foliar Application to Sugar Beet Grown on A Calcareous Soil on Root, Sugar Yields and Nutrient Contents

Kh. A. Shaban and M. A. Negm
Soil, Water and Environment Research Institute, Agriculture Research Centre , Cairo, Egypt.

TWO FIELD experiments were conducted at Noubaria Research Station Farm in two successive winter seasons. Each site soil was normal calcareous of sandy clay loam texture and poor in organic content .Treatments included foliar application of Zn and or B to sugar bet three times with a rate reached in total of 2 kg $ZnSO_4$ and 0.5 kg $Na_2B_4O_7.10H_2O$ (Borax)/fed.

The obtained results could be summarized in the following .
Combination of Zn and B increased significantly root, shoot and root sugar yield over the control.

Amounts of macronutrients (N and K), micronutrients (Mn, Zn and B) in roots and shoots and P in roots only were positively affected with that combination between Zn and B with significant differences over those were not sprayed with Zn or B which were attributed to dry matter responses .

In cases differed from season to the another, Zn or B individually caused significant increases in that studied parameters and in other cases the increments were insignificant while in the both seasons all variables responded significantly to combination of Zn and B spraying treatment .

Soil pH, salinity , equilibration of soluble cations and anions and availabilities of the studied macro- and micronutrients was slightly affected with that treatments through plant root activity in root zone indicating that the more healthy plants are the more effective in agrochemical properties of the soil.

Keywords : Calcareous soil, Zn and B foliation, Sugar beet.

Sugar beet the second crop for sugar production should be given more attention due to yield quantity and quality under the newly reclaimed soils whatever their production limiting factors. Under calcareous soil conditions where pH value tends to alkaline with saturated soil solution high in Ca^{++} cation due to their high $CaCO_3$ contents. Many nutrients face less availability under such conditions. Zinc and Boron are one of these availability limited nutrients in calcareous soils ; (Hodgson *et al.,* 1966 for Zn and Scheffer & White, 1955 for B).

Choice of these two micronutrients to put under study either each of them individually or in combination of each other was related to their effects on ribonucleic acid (RNA) which play the essential role in plant matrix mechanism due to homological and heterological replications, the cell king RNA is the previous step to deoxyribonucleic acid (DNA) formation due to the massaged RNA (m RNA) and adapter RNA(s RNA).

Praske & Plocke (1971) observed that the cytoplasmic ribosomes which usually contain substantial amounts of Zn become extremely unstable with Zn deficiency. They added that this finding may well related to the reduction in RNA synthesis . Also , Robertson & Loughman (1974) showed that B deficiency greatly reduces the rate of incorporation of P into the nucleic acids. Thus , Zn and B play important roles in cell metabolism ; (Jyung *et al.,* 1975 for Zn and Odhroff, 1957 for B) ; carbohydrate and protein synthesis ; Vallee & Wacher (1970) for Zn and Amberger (1975) for B , N assimilation ; (Price *et al.,* 1972 for Zn and Hundt *et al.*, 1970 for B) and P assimilation ; (Olsen , 1972 for Zn and Robertson & Loughman , 1974 for B) .

According to that previous back ground , several investigators applied Zn and B to sugar beet in calcareous soils . El- Fouli *et al.* (2005) in Egypt reported that spraying with micronutrients Fe , Mn, Zn and B was significantly superior in increasing sugar beet root yield and content of sugar . Matsi *et al.* (2005) in Greece found that 14 % of the variance in the sugar beet parameters was explained by soil characteristics and obtained a significant negative correlation between DTPA- extractable Fe , Mn and Zn and soil pH . Tabar (2006) in Iran , found in light – textured soils contained lower total Zn that negative simple correlation coefficients were obtained significantly with all forms of Zn expect organic and soil pH and soluble exchangeable carbonates . Ibrahim & Attia (1990) in Egypt , found that B and Indol acitic acid combination decreased the infestation rate by sugar beet which is the percentage of infestation in 100 leaves to their total area . Geygin *et al.* (2001) in Turkiye found that sugar beet root yield and refined sugar yield increased by 12 and 18 % over control by using soil+ leaf application where 1.2 kg B/ha was sufficient . Kristek *et al.* (2006) in Kroation pointed out that foliar application of 1 kg B/ha twice increased root and sugar yields by 15 and 11 % , respectively , over unfoliated control .

Study of Zn and B foliar application individually or in combination to sugar beet growing in Noubaria calcareous soil , Egypt was the target of the current work .

Material and Methods

Two filed experiment were conducted at Noubaria Research Station farm in two successive winter seasons of 2005 /2006 and 2006/ 2007 where the soil was normal calcareous one having sandy clay loam texture and poor in organic matter content . The plan of work included application of Zn and B individually or in combination with four replicates for each treatment , which arranged in a complete randomized block design as follows : (A) control without Zn or B additions ; (B) foliar application of Zn; (C) foliar application of B and (D) Zn + B. The experiments were started on the 15^{th} of November 2005 in the 1^{st} season and the 20^{th} of November 2006 in the 2^{nd} one, where sugar beat (*Beta vulgaris*) seeds of variety Loil were sown in plots of 3.5 X 6 m^2 size to contain about 120 plants / plot. All plots received phosphorus fertilizer during field preparation at a rate of 15.5 kg P_2O_5 /fed as calcium super phosphate. Potassium and nitrogen fertilizer on two equal dose each of 12 kg K and 10 and kg N / fed as Potassium sulphate and ammonium sulphate, respectively added after 5 and 8 weeks of planying.

Zinc sulphate was applied in spray solution of 3.33 g $ZnSO_4$ / L /plot three times after7,9 and 13 weeks of planting for B and D treatments corresponding a rate of 2 kg $ZnSO_4$.

Borax ($Na_2B_4O_7.10H_2O$) was used as a source of B spraying three times of the same Zn application dates with solution of 0.83 g borax /L/plot corresponding a rate of 0.5 kg borax/ fed for treatments C and D

Sugar beet plants were irrigated in flooding system every 3 weeks in December and January and every 15 days after that till two weeks before plant harvesting which was on the 8^{th} of May 2006 and the 10^{th} of May, 2007 after slight irrigation.

On the day before harvesting, 5 plants of each plot were taken with the soil surrounding roots as plant and soil samples. The plants were washed, divided into roots and shoots and weighed. The obtained roots were prepared to sugar determination after taking some very thin slides for oven dryness. Also a sample of shoots was taken for oven dryness.

The yield of each plot was recorded after obtaining all the plot plants which were roughly cleaned and weighed.

Methods of analyses

Sugar yield and purity

Sucrose % was determined using sacharemeter as g/100 cm^3 of juice according to A.O.A.C.(1990), total soluble solid % (TSS % or Brix %) was determined using hand refractometer from the 6^{th} internodes and purity % was calculated as a ratio of source % to Brix %.

Soil analyses

Mechanical, chemical properties and nutrient availability were determined in the soil collected surrounding roots by the methods described by Black *et al.* (1965) and Soltanpour & Schwab (1977).

Plant analyses

Root or shoot tissues were wet disgusted by mixture of $HClO_4$ and H_2SO_4 acids after Sommers & Nelson (1972). N by semi micro Kheldahl, P spectrophemetecally by sulpho molybdate stannus chloride reagent, K flame photomatrically, Mn, Zn and B by atomic absorption immersion were determined according to Chapman & Pratt (1961).

Obtained data were statistically analyzed according to Snedecor & Cochran (1971).

Results and Discussion

The changes in the agrochemical properties of soil

Tables 2 and 3 presented the data of the soil chemical analyses including nutrient availability , soil pH and salinity . The status of these agrochemical properties could be detected by referring to Table 1 where the determinations were done before sugar beet cultivation in each season.

Regarding to nutrient availabilities after sugar beet harvesting , the changes were generally very slight with decreases than their initial levels in case of available K and Mn . There were some increases over the initial levels in N in the plots of plants foliated with combined Zn + B and P and B in the plots of plants foliated with B alone or in combination with Zn . Available Zn increased by Zn application alone or in combination with B in both seasons in addition to alone B in the 1^{st} season. All these effects were as results of plant behavior in the root zone in the soil on the fact that the more intensive and healthy roots the more active in the rhizosphere . From other wise , there was no way to say that the spray solution lost in the soil from foliation process has any effect on soil properties. Tapar *et al.* (2006) and Kristek *et al.* (2006) obtained similar results who explained that availabilities depressing due to pH value in such calcareous soils.

TABLE 1. The pre- analyses of site soil in the two seasons before sugar beet cultivation .

Season	Particle size distribution (%)				Texture classes	$CaCO_3$ (%)	O. M. (%)
	Clay	Silt	F.sand	C.sand			
1^{st}	19.91	27.90	37.49	14.63	Sandy clay loam	24.16	0.60
2^{nd}	22.11	35.11	33.68	9.10	Sandy clay loam	23.94	0.84

Season	pH (1:2.5)	EC (dS/m)	Cations (meq/100g soil)				Anions (meq/100g soil)			
			Ca^{++}	Mg^{++}	Na^+	K^+	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}
1^{st}	8.04	3.17	0.67	0.27	0.38	0.07	nil	0.12	0.52	0.75
2^{nd}	8.16	2.21	0.57	0.34	0.16	0.08	nil	0.18	0.46	0.51

Season	Macro elements (mg/kg)			Micro elements (mg/kg)		
	N	P	K	Mn	Zn	B
1^{st}	60.43	8.01	125	4.35	1.15	0.125
2^{nd}	58.18	7.00	133	4.62	1.48	0.235

TABLE 2. Available nutrients in mg/kg soil after sugar beet harvesting.

Season	Treatment	Macronutrients			Micronutrients		
		N	P	K	Mn	Zn	B
First	A	57.25	6.22	98	2.71	0.73	0.094
	B	59.75	7.23	118	3.68	1.60	0.124
	C	49.04	8.44	113	3.91	1.38	0.129
	D	76.87	9.15	117	4.25	1.77	0.172
Second	A	51.79	5.17	110	3.15	0.99	0.228
	B	52.37	6.89	122	3.21	1.57	0.230
	C	51.72	7.68	120	3.30	1.41	0.243
	D	71.40	8.27	119	3.99	1.69	0.263

TABLE 3. Some chemical properties of experimental soils after sugar beet harvesting.

Season	Treatment	pH (1:2.5)	SP (%)	EC* (dS/m)	Cations (me/100g soil)				Anions (me /100g soil)			
					Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO^{-}_3	HCO^{-}_3	Cl^{-}	SO^{-}_4
First	A	7.76	45.0	3.23	0.65	0.20	0.55	0.05	nil	0.14	0.58	0.73
	B	7.91	44.5	3.50	0.62	0.17	0.72	0.05	nil	0.12	0.60	0.84
	C	7.93	46.0	3.60	0.60	0.23	0.78	0.05	nil	0.11	0.61	0.94
	D	7.97	45 5	3.38	0.61	0.28	0.58	0.05	nil	0.15	0.58	0.79
Second	A	8.02	52.5	2.24	0.53	0.22	0.37	0.05	nil	0.18	0.53	0.46
	B	8.07	52.0	2 36	0.49	0.23	0.47	0.04	nil	0.18	0.50	0.55
	C	7.93	53.0	2.37	0.48	0.27	0.47	0.04	nil	0.25	0.52	0.49
	D	7.93	53.0	2.34	0.50	0.31	0.40	0.03	nil	0.23	0.50	0.51

* in soil paste extract.

With respect to soil pH , the initial value was decreased in both seasons by sugar beet cultivation with few fraction of pH unit without real change in soil properties but to insure calcareous soil buffering effect. Generally , there were some slight differences as changes in the 1st season treatments not more than 0.27 while in the 2nd season treatments, changes were not more than 0.09. These pH values were of irregular trends among the different treatments .

As for salinity changes , it could be noticed preliminary that the both sites were of normal calcareous soils . It could be found that sugar beet cultivation was without pronounced changes in soil salinity. The increases in soil EC were not more 0.05 and 0.03 dS/m in both seasons respectively when plants were not treated with Zn or B. By application of each or both of them salinity was raised more them 0.40 and 0.15 dS/m in both seasons , respectively. Although salinity was slightly increased in soil past extract, it could be attributed to irrigation water through growth season especially in January , February and March where Na^{+} increased the double of its initial concentration . The value differences were narrow and negligible or in another word,it was not a matter .

Salinity fractions representing soluble cations indicated that the essential nutrient as Ca^{++}, Mg^{++} and K^{+} concentrations decreased by sugar beet cultivation than their initial case especially in treatments received Zn and / or B. There was no presence of CO^{--}_3 where the soil solution was generally near of neutrality and no sodium hazard .

Bicarbonates increased where the biological processes increased especially in presence of B- foliated plants chlorides increased generally after sugar beet harvesting than their initial concentrations due to irrigation water as previously mentioned . Sulphates increased generally after 1st season cultivation in plots of Zn or B treated plants and after 2nd season in plots of plants treated with Zn . On the basis that sulphate was obtained as a difference between total cations and the determined anions (HCO^{-}_3 and Cl^{-}) , this difference contained all other anions as nitrates , phosphates and so on and thus , giving limited explanation for sulphate behavior my not be accurate.

Root , shoot and sugar yields

Data presented in Table 4 revealed that fresh yield of sugar beet roots and shoot were significantly affected with different spray treatments. Boron in the 1st season and combination of Zn and B caused significant increases over the control with 84 and 66 % in the 1st and 2nd seasons , respectively for root yield and about 81 and 63 % for sugar yield on the same respect.

It may be noticed that sugar yields were dependant mainly on root yields without real differences in sugar content percentage or its purity among treatments. These results were in accordance with Ibrahim *et al.* (2002) and Kristek *et al.* (2006).

As for dry matter production of roots and shoots , they followed the same trend of their fresh weights indicating that all treatments produced plants contained the approximate equal quantity of water .This means that all plants reached to the same maturity stage without effect of the used treatments on maturity date.

Nutrient uptake by plants

Macronutrient N, P and K.

Data in Table 5 represented N, P and K amounts in sugar beet roots and shoot for the both seasons.

Nitrogen amounts in roots and its total uptake were found to be significantly higher in plants received boron alone or combined with zinc than unfoliated with Zn+B or foliated with Zn alone in the 1st season . Shoot N in the same season was significantly higher in combination treatment over others and in B treatment over those un foliated with Zn or B. Zinc treatment did not effect on shoot N significantly over un foliated plants with Zn or B. In the second season , each of root , shoot and total N gave the same trend where the combination treatment was significantly higher than those did not received Zn . Plants foliated with Zn were significantly superior to those did not foliated with Zn or B but they were statistically as the same as those foliated with B only . Generally, combination of Zn and B encouraged N uptake significantly over the control .

TABLE 4. Yield compounds, sugar measurements and dry matter content of sugar beet as affected with Zn and B foliation.

Season	Treat-ments	Root yield (ton/fed)		Shoot yield (ton/fed)		Sugar content (%)	Purity (%)	Sugar yield (ton/fed)		Root DM (Ton/fed)		Shoot DM (ton/fed)	
		MV	NSR	MV	NSR	MV	MV	MV	NSR	MV	NSR	MV	NSR
First	A	8.38	b	6.52	b	18.16	84.85	1.52	b	1.82	b	0.87	b
	B	8.44	b	5.65	b	17.64	89.73	1.49	b	1.93	b	0.82	b
	C	16.48	a	9.77	a	17.62	86.79	2.91	a	3.37	a	1.07	ab
	D	15.39	a	10.69	a	17.83	85.31	2.75	a	4.00	a	1.37	a
	LSD 5%	4.46		2.79		--------	--------	0.82		1.34		0.34	
Second	A	7.92	b	6.17	b	17.92	85.74	1.42	b	1.72	b	0.82	bc
	B	10.91	ab	8.12	ab	18.11	86.65	1.98	ab	2.60	ab	1.10	ab
	C	11.25	ab	7.37	ab	17.62	85.12	1.98	ab	2.25	b	0.73	c
	D	13.11	a	9.39	a	17.73	88.20	2.32	a	3.54	a	1.19	a
	LSD 5%	3.46		2.16		------	------	0.63		1.04		0.33	

MV: mean value of 4 replicates .
NSR: non significant ranges.
Treatment (A): control without Zn or B. (B): Zn foliation. (C) : B foliation . (D): Zn + B foliation.
LSD : Least significant differences at 0.05 level of probability.

TABLE 5. Macronutrient N, P and K uptake by sugar beet as affected with Zn and B foliation.

season	Treatments	Root N	Shoot N	Total N	Root P	Shoot P	Total P	Root K	Shoot K	Total K
		MV	MV	MV	MV	MV	MV	MV	MV	MV
First	A	4.30 b	3.20 c	7.62 b	726 c	613 a	1339 c	1278 b	1147 b	2425 c
	B	5.35 b	3.61 bc	9.14 b	1191 bc	474 a	1664 bc	1197 b	1298 b	2616 bc
	C	9.43 a	5.03 b	14.46 a	1563 ab	684 a	2247 b	2188 a	1710 ab	3897 ab
	D	11.48 a	6.95 a	18.45 a	2068 a	729 a	2894 a	2242 a	2218 a	4464 a
	LSD	3.58	1.62	5.10	557	n.s	722	775	644	1319
second	A	4.06 c	3.14 c	7.21 a	687 b	581 a	1267 b	1210 b	1087 b	2296 b
	B	6.97 ab	4.89 ab	12.35 ab	1603 a	633 a	2236 a	1474 ab	2041 a	3515 a
	C	6.38 c	3.46 bc	9.83 bc	1048 b	446 a	1494 b	1400 b	1141 b	2541 b
	D	9.62 a	6.00 a	15.62 a	1839 a	630 a	2468 a	1875 a	1919 a	3794 a
	LSD	2.79	1.66	4.32	535	n.s.	633	439	490	819

MV: mean value of 4 replicates.
NSR: non significant ranges.
Treatment (A): control without Zn or B. (B): Zn foliation. (C) : B foliation . (D): Zn + B foliation.
LSD : Least significant differences at 0.05 level of probability.

Suger beet shoot did not affect with Zn or B applications in increasing their P uptake. As for root and total P uptake , combination of Zn and B raised them significantly over the control. It could be noticed also that B in the st season and Zn in the 2nd one raised root and total P uptake significantly over the control .

As for K uptake , amounts in shoots almost limited the total uptake trend in both seasons . Accumulation of K in roots and shoots were on significant level according to the different treatments . In the 1st season , root K followed the same root N trend where boron alone or combined with Zn was superior significantly to Zn alone or absence of Zn and B . Concerning shoot and total K ,combination of Zn and B was superior to those of Zn only or the control but B only was higher but insignificantly In the second season , Zn was the significant effective in increasing shoot K and total K when it was alone significantly .

Generally, Zn or B foliation increased macronutrient N, P and K accumulations in root and shoots of sugar beet . Some of these increases were significant and some other were insignificant but in all cases , combination of Zn and B gave significant increases over the control plants. That was about similar results obtained by El- Fauly *et al.* (2005).

Micronutrient Mn, Zn and B.

In Table 6 Mn , Zn, and B amounts in roots and shoots of sugar beet for the two seasons are presented .

Manganese uptake was studied as an example of micronutrient trend as affected with other treatments . In the current work , Mn uptake was significantly affected with application of Zn and / or B in the both seasons . In the 1st season combination of Zn and B was significantly superiors to each of them alone or without any of them in case of root , shoot and total Mn. Zn alone had no significant effect on Mn uptake while B had significant effect in case of root and total Mn . In the 2nd season ,zinc alone or combined with B raised significantly shoot and total Mn and only when combined with B in case of roots.

Regarding to Zn uptake , In the 1st season results indicate no significant effect of Zn application on Zn uptake by roots . The significant effect was due to B application alone or in combination with Zn . In the second season , Zn effect appeared for shoots and the total when it was added alone and for roots when it was combined with B . In the same time B alone was statistically as the control .

With respect to B amounts in sugar beet plants of the 1st season , contents of B in roots , shoots and total uptake raised significantly due to treatment whether it was alone or in combination with Zn. In the 2nd one, B alone was effective only in case of its combination with Zn . Nevertheless , Zn was significantly effective in increasing B amounts in roots, shoots and its total uptake over the control . Zinc application was also superior to B alone but with insignificant differences.

TABLE 6. Micronutrient Mn , Zn and B uptake by sugar beet as affected with Zn and B foliation .

Season	Treat-ments	Root Mn	Shoot Mn	Total Mn	Root Zn	Shoot Zn	Total Zn	Root B	Shoot B	Total B
		MV	MV	MV	MV	MV	MV	MV	MV	MV
First	A	32.92 c	46.41 b	79.33 c	47.17 b	37.00 c	84.17 c	21.74 b	60.16 b	81.90 b
	B	39.54 bc	49.78 b	89.82 bc	58.59 b	51.90 bc	106.24 c	26.89 b	63.88 b	90.77 b
	C	67.72 b	67.35 b	135.07 b	104.64 a	60.12 b	164.75 b	50.79 a	96.61 a	147.39 a
	D	96.63 a	91.57 a	187.94 a	141.84 a	87.99 a	229.83 a	67.03 a	121.54 a	186.07 a
	LSD	28.60	20.26	47.31	42.47	18.19	54.59	19.72	27.70	46.15
Second	A	31.14 b	43.04 a	75.18 c	44.65 b	35.15 b	79.81 c	20.59 c	57.07 c	77.65 c
	B	54.16 b	67.21 a	121.36 ab	79.28 b	70.03 a	149.18 ab	36.31 b	86.14 ab	122.45 b
	C	46.08 b	46.22 b	92.30 bc	70.63 b	40.12 b	111.99 c	32.40 bc	65.96 bc	99.35 bc
	D	80.60 a	79.22 a	159.82 a	118.63 a	76.65 a	195.28 a	54.05 a	105.43 a	159.48 a
	LSD	23.15	19.73	41.25	33.54	19.60	50.18	13.82	24.56	36.97

MV: mean value of 4 replicates .
NSR: non significant ranges.
Treatment (A): control without Zn or B. (B): Zn foliation. (C) : B foliation . (D): Zn + B foliation.
LSD : Least significant differences at 0.05 level of probability.

Micronutrients Mn , Zn and B uptake followed also the same trend of macro ones where combination of Zn and B raised significantly Mn, Zn and B raised significantly Mn, Zn and B uptake over the control . When each of them was added alone the increases were significant or insignificant according to their effects on dry matter production of roots and shoots. There were an agreement with El- Fouly *et al.* (2005) and Matsi *et al.* (2005).

References

A.O.A.C. (1995) *"Official Methods of Analysis of the Association of Official Agricultural Chemists"*, 15^{th} ed ., washington, U.S.A.

Amberger, A. (1975) Protein biosynthesis and effect of plant nutrients on the process of protein formation. Fertilizer use and Protein production , *International Potash Inst, Berne.* 75: 89.

Black , C.A.; Evans , D.D. ; Ensminger , L.E.; While, J. L.; Clork, F.E. and Dinauer, R.C. (1965) Methods of Soil Analysis. Ser. Agron. No 9 Amer. Soc. Agron., Madison, Wisconsin.

Chapman, H.D. and Pratt, P.F. (1961) Methods of Analysis for Soils, Plants and Waters , Univ. of California, Division of Agric.Sci.

El- Fouly , M.M.; Rezk, A.L.; Omer , M.A.; Shalaby , E.E. and El-Nasharty , A.B.(2005) Effect of potassium and foliar application of micronutrients on the yield and quality of sugar beet grown in calcareous soil. *Special Issue of the Egypt. J. of Agric . Res.* **2** (2) : 377- 38, Agric. & biological. Res. Division , National Research Center , Egypt .

Geygin, S.; Hamurcu , M. and Apaydin , M. (2001) Effect of boron application on the yield and quality of sugar beet . *Turkish J. Agric & Forestry* **25** : 89 – 95 .

Hodgson , I. F.; Lindsay , W. L. and Trirweiler , J.F. (1966) Micronutrient cation complexiing in soil solution. II. Complexing of Zinc and Copper in displacing solution calcareous soils . *Soil Sci . Soc . Amer. Proc.* **30** : 723- 726.

Hundt. I.; Schilling , G.; Fischer , F. and Bergmann (1970) Investigation on the influence of the micronutrient boron on nucleic acid metabolism. *Thacr- Arch.* **14** : 725- 737.

Ibrahim , M.M.; Khalifa, M.R.; Koriem, M.A.; Zein , F.I. and Omer, E. H. (2002) Yield and quality of Sugar Beet crop as affected by mid to late season drought and potassium fertilization at North Nile Delta. *Egypt. J. Soil Sci.* **42** (1): 87-102.

Jyung, W.H. ; Ehmann, A. ; Schlender , K.K. and Scala , J. (1975) Zinc nutrition and starch metabolism in phaseolus vulgaris L . *Plant Physiol.* **55**: 414 – 420.

Kristek, A. ; Stojic, Biserka and Kristek Suzana (2006) Effect of the foliar boron fertilization on root yield and quality. *Agric . Sci. and Professional Review* **12** (1) : 252- 263 .

Matsi, Th. ; Maslaris , N. and Barbayiannis , N . (2005) Micronutrient levels in sugar beet in soils of Greece . *J. Plant Nutrition* **28** (12) : 2093 – 2099.

Odhroff, C. (1957) Boron deficiency and growth. *Physiol. Plant* **10** : 984- 1000.

Olsen, S. R. (1972) Micronutrient interaction in: *"Micronutrients in Agriculture"*, pp. 243- 264, *Soil Sci Soc . Amer. Inc.* (Ed.), Madison , Wisconsin .

Praske, J. A. and Plocke , D. J. (1971) A role of zinc in the structural integrity of the cytoplasmic ribosomes of *Euglena gracilis* . *Plant Physiol.* **48** : 150 – 155.

Price, C. A. ; Clark , H. E. and Funkhouser, H. E. (1972) Functions of micronutrients in plants . In : *"Micronutrients in Agriculture"* , pp. 731- 742, Soil Sci . Soc., Amer. Inc, Madison, Wisconsin .

Robertson , G.A. and Loughman (1974) Reversible effects of boron on the absorption and incorporation of phosphate in *Vicia faba* L . *New Phytol* . **73** : 291- 298.

Scheffer, F., and White, E. (1955) *"Plant Nutrition"*, 3rd ed ., p. 163, Enke – Verlage Stuttgar .

Snedecor, G.W. and W.G. Cochran (1971) *"Statistical Methods"*, 7th ed .. Iowa State Univ. Press, Ames, Iowa , U.S.A.

Soltanpour, P.N. and Schwal, A. P. (1977) Anew soil test for extraction of macro and micronutrients in alkaline soils . *Soil . Sci. & Plant Analysis* **8**: 195- 207.

Sommers, L.E. and Nelson, D.W. (1972) Determination of total phophorus in soil. Arapid Perchloric acid digestion Procedure . *Soil Sci. Soc . Amer. Proc.* **36**: 902- 904 .

Tabar, A. R.; Karimian , N.A.; Ardalan , M. and Savaghebi , Gh. R. (2006) Zinc fractions of selected calcareous soils of Tahran Province, Iran and their relations with soil properties . 18th World Congress of Soil Science July 9 – 15 Philadenphia , Pennsylvania , U.S.A., No 155- 35.

Vallee, B.L. and Wacker, W.E.C. (1970) Metalloproteinase. In: *"The Protein"*, H. Newrath (Ed.), 2nd ed., Academic Press, New York, **5** : 192.

(*Received* 11/2007;
accepted 12/2007)

تأثير إضافة الخارصين والبورون رشاً على بنجر السكر النامي بأرض جيرية على محصول الجذور والسكر واتجاهات المغذيات

خالد عبده حسن احمد شعبان و محمد عبد السلام نجم
معهد بحوث الأراضي والمياه والبيئة – مركز البحوث الزراعية - القاهرة – مصر .

نفذت تجربتان حقليتان بمزرعة محطة البحوث الزراعية بالنوبارية خلال موسمي زراعة شتويين متعاقبين . وكانت ارض كل موقع منهما عادية جيرية ذات قوام رملي طيني وفقيرة في محتواها العضوي ، وقد شمل المعاملات إضافة الخارصين والبورون معا أو كل بمفرده رشاً لبنجر السكر ثلاث مرات ليصل معدل الإضافة إلى ٢ كجم كبريتات خارصين (زنك) و ٠,٥ كجم بوراكس / فدان.

ويمكن تلخيص النتائج فيما يلي :

اشتراك الخارصين والبورون زاد معنويا من محاصيل الجذور والعروش والسكر عن تلك التي لم تعامل باى منهما وقد سلكت المادة الجافة للجذور والعروش نفس الاتجاه .

تأثرت كميات العناصر الكبرى نيتروجين وبوتاسيوم والعناصر الصغرى منجنيز وخارصين وبورون الممتصة في الجذور والعروش والفسفور في الجذور فقط تأثرا ايجابيا باشتراك الخارصين مع البورون في إضافاتهما رشا بفروق معنوية أعلى من تلك التي لم ترش باى منهما متأثرة في ذلك باستجابة المادة الجافة للمعاملات .

وقد حقق معاملات الرش بالخارصين أو بالبورون منفردين زيادة معنوية في المقيسات محل الدراسة لبعض الحالات اختلف من موسم لأخر بينما لم تكن الزيادات معنوية في حالات أخرى ، إلا أنه فى كلا الموسمين كان اشتراك الخارصين مع البورون محققاً زيادة معنوية فى المقيسات المذكورة.

وقد تأثرت قيم التأثير الايدروجينى والملوحة واتزان الكاتيونات والانيونات الذائبة وصلاحية العناصر الكبرى والصغرى محل الدراسة تأثرا بسيطا بهذه المعاملات من خلال نشاط جذور النبتات في منطقة الجذور مشيرة لكون النبتات الأكثر صحة أكثر تأثيرا على الصفات الكيماوية الزراعية للأرض .