ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Impact of Boron Foliar Application on Quantity and Quality Traits of Sugar Beet (*Beta vulgaris* L.) in Egypt.

Mohamed S Abbas[1*], Mohamed D H Dewdar[2], El- Sayed I Gaber[1], and Hamdy A Abd El-Aleem[3].

[1]Natural Resources Department, Institute of African Research and Studies, Cairo University, Egypt.
[2]Agronomy Department, Faculty of Agriculture, Fayoum University, El -Fayoum, Egypt.
[3]Fayoum Sugar Company, Etsa, El- Fayoum, Egypt.

ABSTRACT

The present investigation was conducted to study the effect of foliar application of boron with different concentrations (0.00; 0.05; 0.10; 0.15; 0.20 and 0.25 g/L) at two different times of foliar applications (80 days and twice at both 80 and 110 days after sowing) on quantity and quality traits of sugar beet in El–Fayoum, Egypt during 2011/2012 and 2012/2013 seasons. The results showed that application of boron showed significant increase for most traits, increasing boron fertilizer up to (0.20) g /L resulted in the highest recoverable sugar in the first season, the highest recoverable sugar was 15.84% with an increase of 15.82 % in the first season compared with the control but in the second season gave significant highest recoverable sugar 16.1% (0.25 g/L), corresponding to an increase of 17.62 % as compared with the control thus, lead to increase sugar yield as follows, the highest sugar yield was 7.516 tons/fedden with an increase of 65.17% in the first season but in the second season gave significant highest sugar yield 9.422 tones/fedden corresponding to increase of 46.14% as compared with the control. Sucrose, recoverable sucrose and juice purity percentages were also increased by adding high level of boron rate.

Keywords: boron, sugar beet, sugar yield, sucrose and time addition

***Corresponding author**

INTRODUCTION

Sugar beet is one of several types of cultivated beets, all of which are included in a single species, *Beta vulgaris*, L. (family of chenopodiaceae). The diversity of plant forms with this species is large, as it includes the familiar red or yellow table beet, leafy foliage beets such as chard, eaten as vegetables or salads greens and fodder beets or mangles, grown for cattle feed.

In Egypt, sugar cane was considered to be the main source for sugar industry up to 1981 season and the cultivation of sugar beet was not known economically before 1982 season. Nowadays, sugar beet became an important crop for sugar in Egypt. Sugar beet contribution to sugar production increased largely from 2.5 % in 1982 to about 48.1% of the total sugar production in 2012. Sugar beet crop has been an important position in Egyptian crop rotation as a winter crop not only in fertile soils, but also in poor, saline, alkaline and calcareous soils [1].

The low availability of micronutrients represents the main problem affecting agricultural development in arid and semiarid regions. Boron deficiency is the second most widespread micronutrient problem and dicotyledon species tend to be more sensitive to boron deficiency than graminaceous crops as well as boron deficiency is a particular problem on alkaline and heavily limed soils and on highly leached sandy soils [2]. Boron is properly more important than any other micronutrients to produce high yield quality of sugar beet. The optimum fertilization with minor elements such as boron is important for sugar beet plants grown in saline soil [3]. Boron is by far the most important trace element needed sugar beet because, without an adequate supply, the yield and quality of roots is very depressed [4]. However, foliar sprays have the advantage that they enable an existing deficiency problem to be treated rapidly [2]. Therefore, the present investigation was to study the effect of foliar application of boron with different concentration at two different times of foliar application on quality and quantity traits of sugar beet.

MATERIAL AND METHODS

The present study was carried out at the experimental farm of the Etsa region at El Fayoum Governorate , Egypt, during the two successive growing seasons of 2011/2012 and 2012/2013 to study the effect of foliar application of boron element (different rates of boron) and (different times of applications). Boron was used in form of boric acid. The multigerm sugar beet variety used in this study was (Top). Physical and chemical analyses of the soil were carried out before planting as showed in (Table 1). Planting dates were on 20th October in the two seasons.

Table 1: Physical and chemical analysis of soil (0-30 cm) of experimental farm of Etsa region.

Physical analysis		Chemical analysis		Available nutrients (mg/kg soil)		Cations (meg/L)	
Sand%	14.6	EC (dsm^{-1})	2.29	Phosphorus	29.7	Na+	19.7
		pH	7.92				
Silt%	28.9	Organic Matter %	2.1	Potassium	217	Ca+	2.2
Clay%	56.5	Total Nitrogen %	0.82	Boron	0.46	Mg++	0.6
Texture	Clay	$CaCO_3$%	11.6	Total Boron	42	K+	0.4

Layout of the experiments:

The two variables investigated in this study were:

- Time of foliar application of boron (A): foliar spray of boron, one at 80 day after sowing (A1) and foliar spray of boron twice at both 80 and 110 days after sowing (A2).
- Concentration of boron (B): B1, 0.00g/L (control); B2, 0.05g/L ; B3, 0.10 g/L ; B4, 0.15 g/L ; B5, 0.20 g/L and B6, 0.25g/L.

At the harvest, (after 210 days from sowing) a random sample of four guarded plants in each sub-plot was taken. Samples were carried immediately to laboratory where roots washed to remove the soil particles. Plants were separated into tops and roots. The following growth characters were determined at harvest: root length (cm), root diameter (cm), root fresh weight per plant (g) and top fresh weight per plant (g). For determining root and top dry weights per plant (g), such parts (tops and roots) were cut into small pieces, and a representative samples were taken from each treatment weighed and dried quickly in an oven at 105 °C till constant weight was reached.

The juice of another representative samples from fresh roots was extracted to determine the following characters: sucrose percentage was determined by using Sacharometer on a lead acetate extract of fresh macerated root according to the procedure of the El-Fayoum Sugar Company [5]. Sucrose percentage, sodium (mEq/ 100 gm of beet), potassium (mEq/ 100 gm of beet) and alpha amino nitrogen (mEq/ 100 gm of beet) were determined by using Analyzer –HG in reception laboratory in El -Fayoum Company.

Sugar loss to molasses percentage=0.343(Na +K) -0.094 (alpha- amino –N) -0.31, according to [6].

Recoverable sugar percentage (RS %) (Corrected sugar %) was determined by using the following formula according to [6]:

RS% =Pol% -0.029 – 0.343(Na+ K) – 0.094 (alpha –amino-N).

Where: Pol% = sucrose %, K, Na and amino –N in Milliequivalent /100 gm in beet

At harvest, plants of all ridges from each subplot were harvested, cleaned, topped and weighed in plus weight of four plant sample and then it was converted to estimate: Root and top yields (ton/fed.).Apparent or gross sugar yield per feddan = (root yield ton/fed x sucrose %).

Statistical analysis: all collected data were statistically analyzed according to technique of analysis of variance "M STAT- C." Treatments were arranged in a split –plot design with four replications. Time of foliar application of boron was allotted to the main plots and different rates of boron to the sub-plots. The differences among treatment means were detected by LSD test at 5% level of probability [7].

RESULT AND DISCUSSION

Root characters

Table 2: Effect of different boron concentrations and time of foliar application on root length and root diameter of sugar beet

Concentration of Boron (B)		Time of Foliar Application (A)							
		Root length (cm)				Root diameter (cm)			
		1st		2nd		1st		2nd	
		A1	A2	A1	A2	A1	A2	A1	A2
B1		33.35	33.35	35.88	35.88	11.66	11.66	11.66	11.66
B2		35.25	36.00	36.56	39.31	12.00	11.98	11.64	12.64
B3		35.87	34.06	36.94	34.50	12.08	12.15	11.99	13.23
B4		37.25	37.75	38.69	39.88	12.43	12.37	12.68	13.49
B5		37.44	38.69	39.56	41.88	12.89	12.49	12.83	13.77
B6		38.31	39.06	40.31	43.88	13.02	13.06	12.81	13.39
$LSD_{0.05}$	A	N.S		N.S		N.S		0.59	
	B	3.52		3.10		0.96		0.79	
	AXB	N.S		N.S		N.S		N.S	

N.S: Not significant

There was significant difference between boron concentrations and not significant difference ($P \leq 0.05$) between two times of foliar boron application on root length and root diameter. The interaction between two variables concentrations of boron (B) x time of foliar application (A) had no significance. However, Data in Table (2) showed that, the rate of 0.25g B/L give higher values of root length as compared with 0.00 g B/L. The average were 38.68 and 42.09 cm for the treatment of 0.25 g B/L in the first and second seasons, respectively, this lead to an increase in the average of root length by 15.98% and 17.31% in the first and second season, respectively as compared with 0.00g B/L. The averages obtained were 36.27 and 36.51 cm during 2011/2012 season for 80 day after sowing and 80&110 days from sowing, respectively. The respective root lengths during 2012/2013 season were 37.99 and 40.00 cm. The increase in root length accompanying higher concentration of foliar application of boron maybe due to its role in enzymes activity which facilitate carbohydrate transportation as well as protein synthesis [8-13] clarified that increasing the concentration of boron significantly increased root length.

Regarding of root diameter, the averages of root diameter were 13.04 and 13.37 cm for treatment of B6 in the first and second seasons, respectively, corresponding to increase in root diameter by 14.66 and 13.21% compared to the control. These values of root diameter were 13.12 and 12.74cm for the two times of applications (at 80 day from sowing one spray and twice spray at 80 &110day from sowing), respectively. Significant increase in root diameter in the second season and combined analysis by 6.93 and 3.49%, respectively at spraying at 80 and 110 days from sowing compared with spraying alone at 80 days from sowing. Such effect of boron might be attributed t o the increase in activities of certain enzymes essential for cell division and the regulation of potassium / calcium ratio in plant [9,12-15] clarified that increasing the concentration of boron significantly increased root diameter. Moreover, [11] reported that dates of spraying were significantly different in root diameter (cm).

Root and top fresh weights

Significant differences ($P \leq 0.05$) were observed between boron treatments applied on root fresh weight in the first season and top fresh weight in the two seasons. While, not significant differences ($P \leq 0.05$) were observed between two times of foliar application on root fresh weight and significantly on top fresh weight in second season. The interaction between concentrations of boron and time of foliar application had no significance. The results in Table (3) revealed that, the average values of root and top fresh weights were 1401.56 and 1561.71 gm in the first season and the combined data for B6 (0.25), respectively these values correspond to increase in root fresh weight by 54.12 and 42.18%, respectively. On the other hand, decrease the concentrations of boron to 0.00 g B\L resulted in the lowest mean values of root fresh weight in both seasons and combined analysis.

Table 3: Effect of different boron concentrations and time of foliar application on root and top fresh weights of sugar beet

Concentration of Boron (B)		Time of Foliar Application (A)							
		Root fresh weight (g)				Top fresh weight (g)			
		1st		2nd		1st		2nd	
		A1	A2	A1	A2	A1	A2	A1	A2
B1		909.37	909.37	1287.50	1287.50	271.88	271.88	400.00	400.00
B2		931.25	1090.62	1312.50	1343.75	284.38	315.63	403.13	606.25
B3		993.75	1243.75	1422.00	1587.50	304.75	365.63	546.88	681.25
B4		1050.00	1337.50	1475.00	1690.62	365.63	387.50	512.50	679.75
B5		1062.50	1368.75	1546.87	1746.87	325.00	328.13	534.38	687.50
B6		1184.37	1618.75	1578.12	1865.62	406.25	406.25	578.13	765.63
$LSD_{0.05}$	A	N.S		N.S		N.S		87.95	
	B	216.49		N.S		75.81		107.35	
	AXB	N.S		N.S		N.S		N.S	

N.S: Not significant

The data in Tables showed that, the increasing the concentrations of boron fertilization from 0.00 to 0.25 g B\L gave the highest top fresh weight 406.250 g with an increase 49.43 % in the first season but in the second season and combined analysis gave significant highest top fresh weight 671.875 and 539.063 g corresponding to 67.97 and 60.47% increase respectively as compared with the control.

The positive effect of the boron element on the top fresh weight of sugar beet could be explained because of its essential role for the activity of enzymes involved in photosynthesis and respiration systems. Also this element is essential for the formation of new leaves. Moreover it has an active role in translation of assimilation product. Similar results were reported by [10], [12] and [13] also the positive effect of boron may be due to the boron role in cell elongation where, in case of boron deficiency, plant leaves were smaller, stiff and thick, [16].

The highest top fresh weight were 636.729 and 491.282 g corresponding to 28.42 and 19.51% increase, respectively at double spraying at 80 and 110 days from sowing compared with spraying at 80 days from sowing only. On the other hand, average values of this trait were not significantly affected by time of foliar application of boron in the first season [11,12,14] reported that dates of spraying were not significantly different in top fresh weight.

Root and top dry weights

Significant differences ($P \le 0.05$) were observed between boron treatments applied on root dry weight in first season and top dry weight in both seasons. While, not significant differences ($P \le 0.05$) were observed between two times of foliar application on root dry weight and significantly on top dry weight in second season. The interaction between concentrations of boron and time of foliar application had no significance as shown in Table (4). However, the average of root dry weight showed significant increase in case of the first season and combined analysis. These average values were 467.18 and 520.60 g for first and combined analysis, respectively, these values corresponding to an increase 54.12 and 42.18% compared with control. On the other hand, decrease the concentrations of boron to 0.00 g B\L in form boric acid resulted in the lowest mean values of root dry weight in both seasons and combined analysis. Supporting results were obtained by [17] and [18] who clarified that increasing the concentration of boron significantly increased root dry weight.

Table 4: Effect of different boron concentrations and time of foliar application on root and top dry weights of sugar beet

Concentration of Boron (B)		Time of Foliar Application (A)							
		Root dry weight (g)				Top dry weight (g)			
		1st		2nd		1st		2nd	
		A1	A2	A1	A2	A1	A2	A1	A2
B1		303.12	303.12	429.16	429.16	55.83	55.83	59.17	59.17
B2		310.42	363.41	437.50	447.91	60.41	63.75	81.25	83.75
B3		331.25	414.58	473.98	529.17	59.37	66.67	84.58	88.33
B4		350.00	445.83	491.67	563.54	69.58	70.41	90.83	94.17
B5		354.16	456.25	515.62	582.25	74.58	76.25	91.66	99.16
B6		394.79	539.58	526.17	621.87	77.50	81.66	94.49	102.30
$LSD_{0.05}$	A	N.S		N.S		N.S		N.S	
	B	72.14		N.S		10.47		16.21	
	AXB	N.S		N.S		N.S		N.S	

N.S: Not significant

Regarding of top dry weight, the obtained values of top dry weight were 79.57, 98.49 and 89.04 g, respectively, these values were corresponding to an increase by 42.54, 66.47 and 54.85% respectively as compared with 0.0 treatment boron (control). Furthermore, the beneficial effect of the treatments B2, B3, B4 and B5 compared to the control (B1). Similar results were obtained by [19] and [20] clarified that increasing the concentration of boron significantly increased top dry weight.

Sodium, potassium and alpha-amino nitrogen contents

Overall results showed significant differences at the 5% level among different concentrations of boron applied on sodium, potassium and alpha-amino nitrogen contents. While, significant differences were observed between two times of foliar application on sodium and alpha-amino nitrogen contents in the second season only. The interaction between concentrations of boron and time of foliar application had no significance. However, data in Tables (5) revealed that, increasing the concentrations of boron fertilization from 0.00 to 0.25 g B\L gave the lowest sodium content of 1.66 mEq with a decrease 32.63 % in the first season but in the second season and combined analysis gave significant lowest sodium content 1.734 and 1.7 mEq corresponding to 33.05 and 32.83% decrease as compared with the control, respectively. On the other hand, decrease the concentrations of boron to 0.00 g B\L resulted in the highest mean values in both seasons. These results were in line with those findings by [12], [15], [21] and [20] clarified that increasing the concentration of boron significantly decreased sodium content. However, the significant lowest sodium content 1.986 and 1.955mEq corresponding to decrease in impurity 4.98 and 9.03% respectively at application of boron at 80 and 110DAS as compared with boron application only at 80 DAS, the least accumulation of sodium at 110 DAS can be due to the fact that increased leaf area in this date will facilitate the increase in boron absorption. Supporting results were obtained by [12] who reported that dates of spraying were significantly different in sodium content.

Table 5: Effect of different boron concentrations and time of foliar application on sodium, potassium and alpha-amino nitrogen contents of sugar beet

Concentration of Boron (B)		Time of Foliar Application (A)											
		Sodium (mEq/100 gm of beet)				Potassium (mEq/100 gm of beet)				Alpha-amino nitrogen (mEq/100 gm of beet)			
		1st		2nd		1st		2nd		1st		2nd	
		A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2
B1		2.47	2.47	2.59	2.59	5.30	5.30	5.36	5.36	0.52	0.52	0.48	0.48
B2		2.57	2.23	2.24	2.19	4.81	4.79	4.74	4.65	0.38	0.29	0.43	0.25
B3		2.22	1.89	1.90	2.07	4.54	4.45	4.30	4.19	0.35	0.18	0.36	0.21
B4		2.02	1.77	2.07	1.67	4.50	4.44	4.46	3.84	0.25	0.18	0.31	0.17
B5		2.13	1.70	1.90	1.78	4.30	4.27	4.42	3.51	0.21	0.18	0.25	0.16
B6		1.85	1.49	1.85	1.62	4.24	3.35	3.93	3.48	0.10	0.10	0.23	0.11
$LSD_{0.05}$	A	N.S		0.09		N.S		N.S		N.S		0.09	
	B	0.35		0.38		0.38		0.44		0.25		0.12	
	AXB	N.S		N.S		N.S		N.S		N.S		N.S	

N.S: Not significant

Regarding of potassium contents, increasing the concentrations of boron fertilization from 0.00 to 0.25 g B\L gave the highest potassium content 3.794 mEq. with a decrease of 28.45 % in the first season but in the second season and combined analysis gave significant lowest potassium content 3.702 and 3.748mEq, corresponding to 30.93% and 29.69% decrease as compared with the control respectively. On the other hand, decrease the concentrations of boron to 0.00 g B\L resulted in the highest mean values of potassium content in both seasons and combined analysis. The results found in this study are inconsistent with those of [22] who reported that boron application had no impact on potassium content in sugar beet root. While, [20] found that the effect of different concentration of boron application was significant at different concentration of boric acid, the only significant differences were between the concentration of 4% boric acid and that of the control; also [23] reported that boron fertilization and increasing levels from 0 to 0.6% significantly affected potassium concentration. Whereas, [12] and [15] found that potassium content significantly responded to applied boron fertilizer levels in only the second season. On the other hand, [24] mentioned that B application induced ·some increases in K% in sugar beet but most increases were clear but mostly below the level of significance. Moreover, [25] and [21] reported that B application increased juice quality by decreasing K content.
Concerning alpha amino nitrogen, the increasing of boron concentrations from 0.00 to 0.25 g B\L gave the highest alpha amino nitrogen 0.0965 mEq. with a decrease 81.33% in the first season but in the second season and combined analysis gave significant lowest alpha amino nitrogen content of 0.168 and 0.133 mEq corresponding to a decrease of 64.85% and 73.29%, respectively, as compared with the control. On the other hand, decrease the concentrations of boron to 0.00 g B\L resulted in the highest mean values of alpha amino nitrogen in both seasons and combined analysis. Similar trend was observed by [15]. On the contrary, [12], [21] and [20] who reported that B application increased alpha-amino nitrogen content. Moreover, the least amount of alpha amino nitrogen was observed at 80 and 110 days, but significantly affect it in the second season and combined analysis and gave lowest alpha amino nitrogen content 0.227 and 0.214 mEq at (spraying at 80 and 110 days) corresponding to decrease by 33.23% and 33.12% respectively compared with spraying only at 80 days. Supporting results were obtained by [12] who reported that dates of spraying were significantly different in alpha amino nitrogen.

Sucrose, sugar loss and recoverable sugar percentages

Results in Table (6) indicate that, the differences among different concentrations of boron on sucrose, sugar loss and recoverable sugar percentages were significant at the 5% level on both seasons. While, significant difference was observed between two times of foliar application on sugar molasses loss percentage only in the first season. The interaction between concentrations of boron and time of foliar application had no significance. However, careful observations of data clearly showed that, the increasing the concentrations of boron fertilization from 0.00 to 0.25 g B\L gave the highest sucrose content percentage 17.89% (at 0.25 B/L), with an increase 7.1 % in the first season but in the second season and combined analysis gave significant highest sucrose content percentage 18.472% (at 0.20 B/L) and 18.308%(at 0.20 B/L) corresponding to increase by 11.14% and 9.88 % respectively, as lowest mean values of sucrose content in both seasons and combined compared with the control . The present findings are in harmony with those obtained by [26], [10], [11], [15], [21] and [20] who reported that boron application increased sugar content .On the other hand, [23] and [27] reported that boron application did not affect root sugar content. Meanwhile, [24] found that application of B at highest level (1 kg/fed.) insignificantly increased sucrose percentage.

Table 6: Effect of different boron concentrations and time of foliar application on sucrose, sugar molasses loss and recoverable sugar percentages of sugar beet

Concentration of Boron (B)		Time of Foliar Application (A)											
		Sucrose (%)				Sugar molasses loss (%)				Recoverable sugar (%)			
		1^{s}		2^{nd}		1^{st}		2^{nd}		1^{st}		2^{nd}	
		A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2
B1		16.71	16.71	16.62	16.62	2.43	2.43	2.44	2.44	13.67	13.67	13.69	13.69
B2		16.82	17.06	16.80	16.94	2.15	2.03	2.14	2.10	14.07	14.38	14.06	14.24
B3		17.10	17.31	17.11	17.38	1.96	1.79	2.11	1.93	14.29	14.91	14.49	14.84
B4		17.30	18.06	17.39	18.35	1.85	1.63	1.97	1.89	14.85	15.86	14.82	15.87
B5		17.09	18.60	17.85	18.10	1.77	1.49	1.84	1.77	15.32	16.36	15.42	16.73
B6		17.99	17.79	18.80	17.80	1.69	1.40	1.80	1.41	15.71	15.79	16.41	15.79
$LSD_{0.05}$	A	N.S		N.S		0.14		N.S		N.S		N.S	
	B	0.97		0.93		0.21		0.16		0.48		0.86	
	AXB	N.S		N.S		N.S		N.S		N.S		N.S	

N.S: Not significant

Regarding of sugar loss percentage, increasing the concentrations of boron fertilization from 0.00 to 0.25 g B\L gave the lowest sugar molasses 1.542g with a decrease of 36.46% in the first season but in the second season and combined analysis gave significant lowest sugar molasses 1.600 and 1.571g corresponding to decrease of 34.37 and 35.4 % respectively. On the other hand, decrease the concentrations of boron to 0.00 g B\L resulted in the highest mean values of sugar molasses in both seasons and combined analysis. The decrease in sucrose loss to molasses accompanying higher boron rates may be due to the decrease in impurities in terms of Na, K and a-amino nitrogen content in beet roots. These results were in line with those findings by [10] who clarified that increasing the concentration of boron significantly decreased sugar molasses.

Concerning recoverable sugar percentage, increasing the concentrations of boron fertilization from 0.00 to 0.25 g B\L gave the highest root recoverable sugar 15.835% with an increase of 15.82% at (concentration 0.25g B/L) in the first season but in the second season and combined analysis gave significant highest recoverable sugar 16.100% (at 0.25g B/L) and 15.954% (at 0.20g B/L), corresponding to an increase of 17.62 % and 14.43 %, respectively compared with the control. On the other hand, decrease the concentrations of boron to 0.00 g B\L resulted in the lowest mean values of recoverable sugar in both seasons and combined analysis. The increase in recovery sugar percentage may be due to the increase in sucrose percentage and the decrease in impurities in terms of Na, K and a-amino nitrogen percentage. This is in general agreement with the work done by some investigators among them [29], [30] and [31].

Root, top and sugar yields

Significant differences ($P \leq 0.05$) were observed between boron treatments applied on root yield in the first season, top yield and sugar yield in the two seasons expect root yield in second season. While, insignificant differences ($P \leq 0.05$) were observed between the two times of foliar application on root yield, sugar yield and significantly on top yield in the first season. The interaction between concentrations of boron and time of foliar application had no significance. The results in Table (7) revealed that, increasing the concentrations of boron fertilization from 0.00 to 0.25 g B\L gave the highest root yield per feddan 42.050 tones with an increase of 54.11% in the first season but for the combined analysis gave significant highest root yield per feddan, 46.854 tones with an increase of 42.39 % in root yield per feddan as compared with the control. On the other hand, decrease the concentrations of boron to 0.00 g B\L resulted in the lowest mean values of root yield per feddan in both seasons and combined analysis. The increase in root yield accompanying boron foliar application is due to the increase in root length, root diameter and mean root weight as mentioned before. These results are in harmony with those obtained by [22], [9], [10], [11], [12], [32], [21] and [13].

Table 7: Effect of different boron concentrations and time of foliar application on root, top and sugar yields of sugar beet

Concentration of Boron (B)		Time of Foliar Application (A)											
		Root yield (ton/fed.)				Top yield (ton/fed.)				Sugar yield (ton/fed.)			
		1st		2nd		1st		2nd		1st		2nd	
		A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2
B1		27.29	27.29	38.63	38.63	8.16	8.16	12.00	12.00	4.55	4.55	6.45	6.45
B2		27.94	32.72	39.33	40.32	8.54	9.47	12.10	18.19	4.69	5.58	6.65	6.83
B3		29.81	37.32	42.67	47.63	9.15	10.97	16.41	20.44	5.12	6.46	7.32	8.30
B4		31.50	40.13	44.26	50.72	10.97	11.63	15.38	20.40	5.45	7.24	7.62	9.26
B5		31.88	41.07	46.41	52.41	9.75	9.85	16.04	20.63	5.70	7.66	8.29	10.04
B6		35.54	48.57	47.35	55.97	12.19	12.19	17.35	22.97	6.42	8.62	8.86	9.99
$LSD_{0.05}$	A	N.S		N.S		N.S		1.95		N.S		N.S	
	B	5.39		N.S		1.82		2.68		1.00		1.54	
	AXB	N.S		N.S		N.S		N.S		N.S		N.S	

N.S: Not significant

Regarding of top yield, increasing the concentrations of boron fertilization from 0.00 to 0.25 g B\L gave the highest top yield per feddan, 12.190 tones with an increase of 49.42 % in the first season but in the second season and combined analysis gave significant highest top yield per feddan 20.157 and 16.173 tones corresponding to an increase of 67.97% and 60.46%, respectively as compared with the control. On the other hand, decrease the concentrations of boron to 0.00 g B\L resulted in the lowest mean values of top yield per feddan in both seasons and combined analysis. The positive effect of boron on top yield per feddan could be explained according to the fact that Boron is essential for the formation of new cells in meristems and consequently favor leaf formation. These results are in accordance with those obtained by [9], [10], [11], [12], [32], [21] and [13].

Concerning sugar yield, increasing the concentrations of boron fertilization from 0.00 to 0.25 g B\L gave the highest sugar yield per feddan, 7.516 tones with an increase of 65.17 % in the first season but in the second season and combined analysis gave significant highest sugar yield per feddan, 9.422 tones and 8.469 tones corresponding to an increase of 46.14% and 54.01%, respectively as compared with the control. On the other hand, decrease the concentrations of boron to 0.00 g B\L resulted in the lowest mean values of sugar yield per feddan in both seasons and combined analysis. Such effect of high boron rate may attributed to the increase in sucrose and recoverable sugar percentages as well as roots yield. These results in general go in line with those obtained by some investigators among them: [26], [10], [11], [12], [15], [32], [21] and [13] However, [33] found that root and sugar yields were increased by increasing boron fertilizer up to 0.3 Kg/da. Supporting results revealed insignificant differences of foliar application times on root yield and top yield were obtained by [21] who reported that dates of spraying were not significantly different in top yield per feddan. Also, [20] who reported that dates of spraying were not significantly different varied on root yield per feddan.

CONCLUSIONS

Application of boron rates showed significant increase for most traits under study, the increasing of boron fertilizer up to (0.20) g/L resulting in the highest recoverable sugar in the first season thus lead to increase sugar yield. Sucrose, recoverable sucrose and juice purity percentages were also increased by adding high level of boron rate. Such increases of these traits due to adding high level of boron might be attributed to decrease of Na, K and alpha amino nitrogen uptake in root juice. As for the effect of time of foliar application, the applied reminder 5 rates of boron fertilizer at 80 and 110 day after sowing showed comparable values for the most studied traits. The significant interactions between the two investigated variables during the two seasons are mostly for the traits under the study.

REFERENCES

[1] Gobarah, ME, Mekki BB. J App Sci Res 2005;1(5): 373-379.
[2] Alloway BJ. Micronutrient Deficiencies in Global Crop Production. Springer Science 2008.
[3] El-Hawary MA. Al-Azhar J Agric Res 1994; 20: 25-35.
[4] Cooke DA, Scott RK. The Sugar Beet Crop. Chapman and Hall London; 1993mpp. 262-265.
[5] Le-Docte A. Int Sug J 1972;29:488-492.
[6] Reinfeld E Emmerich G Baumgarten C Winner and U Beiss. 1974. Zur voraussage des Melassezzuckers aus Rubenanalysen Zucker 27, 2-15.c.f .The sugar beet crop, Edit .by Cooke DA, R K Scott. First Edit. 1993, Chapman &Hall, World Crop Series, London, U.K.
[7] Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research, Wiley and sons, New York 1984.
[8] Osman AMH, GS El-Sayed, MSH. Osman and KS El- Sogheir. Annals J Agric Sci Moshtohor 2003;41(3):1135-1152.
[9] Azzazy NB. Egypt J Appl Sci 2004;19(8): 230- 238.
[10] Enan SAM. 2004. Effect of transplanting and soil application of boron and zinc on yield and quality of sugar beet. Ph.D. Thesis, Fac. Agric. Al-Azhar Univ., Egypt.
[11] Aly MSM. 2005. Study of some factors affecting productivity of sugar beet. Ph. D. Thesis, Fac. Agric.Al-Azhar Univ., Egypt.
[12] Saad NR 2005. Effect of some agricultural practices on sugar beet under newly reclaimed land. M.Sc. Thesis Fac. Agric. Minia Univ.
[13] Abido WAE. Int J Agr Sci 2012;4(7):287-292.
[14] Osman AMH, GS EL-Sayed and Al Nafei. J Appl Sci 2004;19(2):76-98.
[15] Ibrahim BS 2006. Sugar beet types and some microelements in relation to yield and quality. M.Sc. Thesis, Fac. Agric. Banha Univ., Egypt.
[16] Brown PH, Hu H. Ann Bot 1996; 77: 497-505
[17] Ebrahim MH G Sobhy R Sorour and AM Omar 1988. Varietal response of sugar beet to foliar application of some micronutrients. Proc. 3rd Egypt. Conf. Agron. Kafr El- Sheikh, 5-7Sept., 324-334.
[18] Hassanin AM MS Osman, N. M. Darwish; N. F. Dawla and M.A. Shahin (1986). Effect of boron and gibberellic acid on growth of sugar beet plants. Al-Azhar univ. Agric.Res.6:505-514.
[19] Eweida, MHT, AA El Gharabawy, SY Besheit and KH EL-Shenawy. 1994. growth, quality and yield of sugar beet as affected by foliar application of some micronutrients. Proc. six Conf. Agron., Al Azhar Univ., Cairo Egypt,
[20] Armin M and Asgharipour M. American-Eurasian J Agric Environ Sci 2012;12(4):444-448.
[21] El- Kammash TNM. 2007. Effect of nitrogen and boron fertilization on yield and quality of sugar beet in Kalabsho Area, Dakahlia Governorate. M.Sc. Thesis, Sugar Technology Res. Inst. Assiut Univ. Egypt.
[22] Kristek A, B Stojic and S Kristek. Agriculture- Scientific and Professional Review 2006;12(1):1-7.
[23] Hussein Magd A. Alex J Agric 2002;47(2):201-207.
[24] Abd El-Gawad AM, SAH Allam, LMA Saif and AMH Osman. Egypt J Agric Res 2004; 82(4): 1681-1701.
[25] Narayan D, AS Chandel and GR Singh. Indian J Plant Physiol 1989;37(2):164-168.
[26] Piszczek J. 2001. Influence of leaf fertilizers Borvit and Tytanit on health and quality of sugar beet. Poznan, Poland, 41(1): 306-311.
[27] Ciecko Z, K Grzegorzewski, A Zonowski and T Najmowic. Biulety Instytutu. Hodowli Aklimatyzacji Roslin 2004; 234):137-143.
[28] Moustafa Zeinab R, Saffa SM El- Sayed, Shafika M Nasr and AME Goma. 2006. Physico – chemical properties, quality and yield as affected by foliar spray with boron and sulphur in sugar beet plant. Ed. & Publ. By the Fac. Agric., Minufiya Univ., Shebin El-kom, Egypt, 31 (4): 957-970.
[29] Ramadan BSH, HR Hassan and Abdo Fatma A. Egypt J Agric Res 2003;82(4):1733-1745.
[30] Ramadan BS H, AM Nassar. Egypt J Agric Res 2004; 82(3):1253-1268.
[31] Ferweez H H M Abbas and BM Abou El-Magd. Minia J Agric Res Develop 2006; 26(1):27-44.
[32] Maghrabi, AEAA. 2006. Effect of plant density and fertilization on growth and yield of sugar beet. Ph.D. Thesis, Fac. Agric., Al Azhar Univ., Egypt.
[33] Gezgin S M hamurcu M Apaydin. Turkish J Agr Forestry 2001; 25: 89- 95.