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Yield and Chemical Composition of Sugar Beet in Response to Potassium Rates, Bio and Foliar Fertilizations

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ABSTRACT

A field experiment was conducted at Bilqas distrect, Dakahliya Governorate, Egypt to evaluate the effects of potassium rates, bio foliar fertilization on yield and quality of sugar beet *(beta vulgaris L.)* during 2014/2015 and 2015/2016 winter seasons. Split plot design with three replicates was performed. The main plots were assigned by three levels of potassium fertilization of (0, 24 and 48 kg K_2O fed^{-1}) added as potassium sulfate (48% K_2O). The sub plots were occupied by (four treatments) 1-Untreated control. 2- bio-fertilizer (potassium solvent bacteria) *Bacillus circulans* 3-Foliar fertilization of potassium humate at the rate 1 L fed^{-1} per 400 liter water. 4- Foliar fertilization of boron at the rate 1 L fed^{-1} per 400 liter water. Data revealed that the highest mean values of fresh weights of shoots and roots, sugar yield (kg fed^{-1}), N%, K%, sucrose% and quality% in roots of sugar beet were obtained from 48 kg K_2O fed^{-1} fertilization with boron treatment compared with all the other treatments. Meanwhile, the lowest values were obtained from the control without K fertilization and without boron fertilization during both seasons. Sodium (Na %) decreased with increasing potassium fertilization in both seasons. It is worthy to that both bio K fertilization and K humate addition also had positive effects during both seasons.

Keywords: Sugar beet, K fertilization, foliar fertilization, boron, sucrose% and Sugar yield.

INTRODUCTION

Improving sugar beet (*beta vulgaris* L.) yield and quality are the main goals of the governmental policy to increase sugar production to gradually cover gap between sugar consumption and production. Approximately 66 % of our local needs from the white sugar are produced locally from sugar beet and sugar cane while, the rest (34 %) is imported. Increasing production from unit area and water by using fertilization and agricultural practices are considered one of the important national targets to minimize gap between sugar consumption and production, fertilizer is considered as a limiting factor for obtaining high yield and quality (Hozayn *et al*., 2013).

Potassium is one of the essential elements affect sugar beet productivity especially at saline soil. Thus application of suitable potassium fertilizers level may increase the production of sugar beet (Abdel-Mawly and Zanouny, 2004).

Potassium is a mobile element in plant tissues. It plays a role in the physiological processes of the plant such as respiration, transpiration, translocation of sugars and carbohydrates, energy transformation and enzymatic actions. Potassium is essentially an element in plant life, promotes root growth and is conducive to greater sugar accumulation through its role in the process of photosynthesis (El-Essawy, 1996).

Many investigators have confirmed the role of K in increasing the yield and quality of sugar beet by enhancing the biosynthesis of organic metabolites and improving nutritional status (Fathy *et al*., 2009).

Boron is by far the most important of the trace elements needed by sugar beet. Boron deficiently depressed the yield and quality of sugar beet. Soil application, as well as, a foliar spray of boron is equally effective, hence the root fresh weight, sucrose %, root and top yields significantly increased by increasing boron levels (Mekdad, 2015).

The main functions of boron are related to the strength and development of the cell wall, cell division, fruit and seed development, sugar transport and hormonal development. (Marschner, 1995).

The objective of this study was to evaluate the response of sugar beet yield and chemical composition to potassium rates, bio and foliar applications.

MATERIALS AND METHODS

A field experiment was carried out in a clayey textured soil (*Clayey, Smectitic, Superactive, Mesic, Typic*) located at a private farm in Bilqas distrect, Dakahliya Governorate, Egypt (31° 13' 37.87'' N latitude and 31° 19' 53.91'' E longitude) to evaluate the effects of potassium rates, bio and foliar fertilization on yield, quality and chemical compassion of sugar beet *(beta vulgaris L.)* during 2014/2015 and 2015/2016 winter seasons.

The samples were directly transferred to the laboratory, cleaned with distilled water to get free from any adherent dust, then at harvest, the vegetative samples were separated into two parts (tops+ roots) then weighted fresh (kg fed^{-1}).

Dry weight of top parts and roots were recorded for each sample after drying in an electric oven at 70°C for 24 hours. Moreover, dried material of tops and roots were ground to a fine powder and kept in stopped glass bottles for chemical analyses.

Soil samples were collected from the experimental field (0-30 cm), air dried and passed through 2 mm sieve to determine some physical and chemical properties according to the standard method recorded by (Cooke and Scott , 1993). Some physical and chemical properties of the experimental soil are shown in Table 1.

Split plot design with three replicates was performed. The main plots were assigned by three levels of potassium fertilization of (0, 24 and 48 kg K_2O fed^{-1}) added as potassium sulfate (48% K_2O). The sub plots were occupied by (four treatments) 1- untreated control. 2- with bio-fertilizer (potassium solvent bacteria) *Bacillus circulans.* 3- foliar fertilization of potassium humate. 4- foliar fertilization of boron. Both of potassium humate and Boron applied at the rate 1 L fed^{-1} per 400 liter water as foliar spray in three sprays (30, 60 and 90 days after seeding).

Random plant samples of 4 plants were taken from each treatment (after 120, 150 and 180 days from sowing) to study the differential responses parameters: Fresh weight of the shoots (kg fed^{-1}) and fresh weight of the roots (kg fed^{-1}).

Biofertilizers (potassium solvent bacteria) *Bacillus circulans* was obtained from Department Soils Microbiology, Water and Environment Research Institute, ARC (Sakha Station). Boron fertilizers (Commercial compound consists of 8.5% Boric acid) and potassium humate (10% K_2O) were obtained from Department of Plant nutrition and soil fertility, Soils, Water and Environment Research Institute, ARC (Sakha).

Table 1. Some physical and chemical properties of the studied soil:-

Soil properties		Values	
		Season 1	Season 2
Particle size distribution%	C. Sand	3.0	3.3
	F. Sand	21.3	20.8
	Silt	26.9	27.0
	Clay	48.8	48.9
	Soil texture	Clayey	Clayey
E.C.dS.m^{-1}(soil paste)		1.4	1.2
pH(1:2.5)		7.9	7.8
S.P. %		58	60
Organic matter (%)		1.18	1.80
Calcium carbonate %		3.5	3.7
Soluble cations (meq L solution)	Ca^{++}	1.60	1.40
	Mg^{++}	4.00	3.07
	Na^{+}	8.09	7.50
	K^{+}	0.13	0.22
Soluble anions (meq L solution)	CO_3^{--}	----	----
	HCO_3^{-}	3.88	2.90
	Cl^{-}	7.15	6.37
	SO_4^{--}	2.79	2.92
Available nutrients (ppm)	N	45.00	49.00
	P	13.10	12.40
	K	275.60	280.08
	B	0.70	0.80

Sugar beet cultivation on October, 23th of 2014/2015 and 2015/2016 seasons, sugar beet variety Top are sown in the soil. The plot unit space 2.5*3.5= 8.75 m^2 (5 ridges (70cm) * 2.5 long).

Samples of plants were wet digested with a mixture of sulphuric and perchloric acids (Piper 1950), total nitrogen was determined using the Kjeldahl method by Hesse, (1971), phosphorus was determined calorimetrically according to Schouwenburg and Waling, (1967). Potassium was estimated using a flame photometer as described by Jackson (1967).

Boron was extracted by hot water and demined calorimetrically according to Cottenie *et al*., (1982).

Samples of roots were randomly chosen from each plot to determined root quality index (i.e. juice quality, sucrose content, impurities and extractable sugar %) at the quality laboratory, Bilqas Sugar Factory, Dakahliya Governorate, Egypt. Potassium, sodium and nitrogen concentration (expressed as a mill equivalent 100 g^{-1} of beet) and sucrose% were estimated according to procedure of Sugar Company by an Automatic Sugar Polarimetric described by Cooke and Scott (1993).

The data were analyzed statistically using the ANOVA technique and the least significant differences between the means of treatment were compared as published by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1- Fresh shoots, roots and sugar yield of sugar beet.

Data illustrated in Table 2 show that, the effects of potassium rates, bio and foliar fertilization on fresh weights and sugar yield of sugar beet (kg fed^{-1}) during the two successive seasons 2014-2015 and 2015-2016.

- Effect of potassium fertilization:

Data of Table 2 and show that there were significant differences between mean weights of fresh shoots and roots and sugar yield of sugar beet (kg fed^{-1}) due to potassium fertilization, where 48 kg K_2O fed^{-1} had the highest shoots fresh weights in 1st and 2nd season of (4150.00) kg fed^{-1} and (4900.00) kg fed^{-1} compared with (3764.79) , (3942.50) kg fed^{-1} of the control as well as the fresh roots weights (26917.00 and 27420.00) kg fed^{-1} compared with (22827.50 and 24861.00) kg fed^{-1} of the control. Also, sugar yield weights of sugar beet was (5270.93 and5370.88) kg fed^{-1} compared with (4068.63 and 4667.21) kg fed^{-1} of the control in 1st and 2nd season, respectively. Where, increase percentages of weights of fresh shoots (10% and 24%) and roots (17% and 10%). Which led to an increase sugar yield (30% and 16%) of sugar beet over control in both seasons, respectively (Fig 1). This might be attributed to effect of potassium on photosynthesis, as well as, transport of the photosynthetic product from the leaves to the root. These results could be enhanced with those obtained by (Fathy *et al*., 2009; Abido *et al*., 2015; and Kashem *et al*., 2016).

Table 2. Means of fresh weight and sugar yield (kg fed^{-1}) of sugar beet as affected by potassium rates, bio and foliar fertilization at harvest stage during 2014/15 and 2015/16 seasons.

Treatments	Fresh weight kg fed^{-1} after 180 days from sowing				Sugar yield kg fed^{-1}	
	First season		Second season			
	Shoots	Roots	Shoots	Roots	First season	Second season
Without K_2O fert	3764.80	22818.30	3942.50	24861.00	4068.60	4642.20
24 units K_2O fert	4045.00	24644.10	4390.00	26340.00	4636.20	5101.30
48 units K_2O fert	4150.00	26917.00	4898.30	27420.00	5270.90	5370.70
F. test	NS	*	*	*	*	*
LSD at 0.05	-	453.7	63.9	160.3	30.8	32.6
Control	3396.40	22493.30	4206.60	23148.00	3852.80	4229.00
Bio fert	3840.00	23749.30	4346.60	24000.00	4357.40	4504.10
K Humate	4246.60	26000.00	4457.70	26720.00	5019.80	5103.20
B fert	4463.30	26930.00	4630.00	30960.00	5404.20	6315.90
F. test	*	*	*	*	*	*
LSD at 0.05	410.2	388.6	57.3	55.3	91.7	94.8

- Effect of bio fertilization:

The effect of bio fertilization on weights of fresh shoots and roots and sugar yield of sugar beet (kg fed^{-1}) is significant in the both seasons. Fresh shoots weights (3840.00 and 4346.60) kg fed^{-1} tended to increase with fertilized plants by biofertilizer as compared with (3396.40 and 4206.60) kg fed^{-1} under the control in the 1st and 2nd season as well as the fresh sugar beet roots (23749.30 and 24000.00) kg fed^{-1} under biofertilizer treatment compared with (22493.30 and 23148.00) kg fed^{-1} under the control in the 1st and 2nd season, respectively. The mean values of sugar yield were (4357.40 and 4504.10) kg fed^{-1} tended to increase with fertilized plants with biofertilizer. These results are in harmony with those obtained by Amin *et al*., (2013) and Rassam *et al*., (2015).

- Effect of humate potassium:

The effect of humate potassium on weights of fresh shoots and roots and sugar yield of sugar beet (kg fed^{-1}) is significant in the both seasons.

Regarding the effect of foliar fertilization (humate potassium), data in Table 2 showed that the highest values of shoots were (4246.60 and 4457.70) kg fed^{-1} compared to (3396.40 and 4206.60) kg fed^{-1} in the control. The fresh sugar beet roots were (26000.00 and 26720.00) kg fed^{-1} under Humate potassium compared with (22493.30 and 23148.00) kg fed^{-1} under the control in the 1st and 2nd season.

Table 2 showed that potassium humate increased sugar yield (5019.80 and 5103.20) kg fed^{-1} compared with (3852.80 and 4229.00) kg fed^{-1} of the control during both seasons.

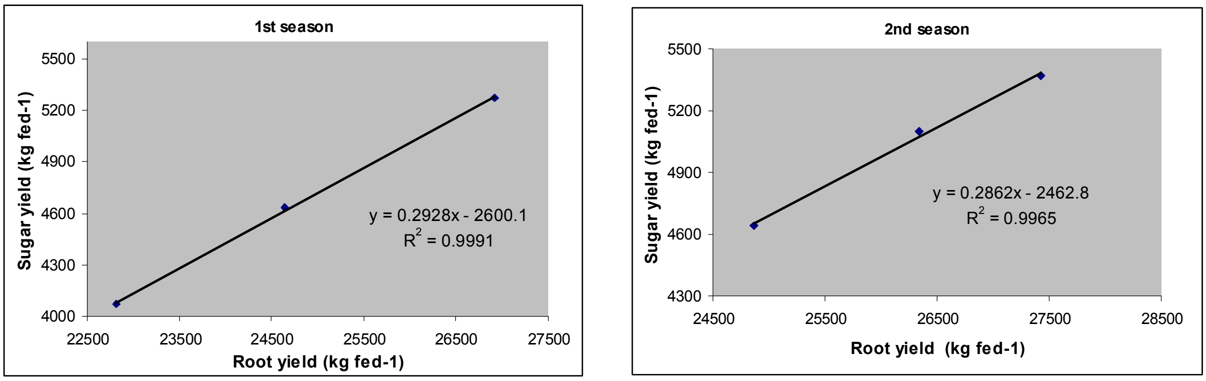

Fig. 1. Relations between root yield and sugar yield of sugar beet plants under different rates of potassium fertilizer at 1st and 2nd season.

- Effect of boron fertilization:

Shoots and roots fresh weight of sugar beet is significantly improved by boron fertilization (Table 2).

The sequence of the shoot and root yield from the high to low was boron foliar spray > K-humate foliar spray > biofertilization soil application > control in both seasons.

These results could be enhanced by those obtained by Knany *et al*., (2009), Mekdad (2015) and Enan *et al*., (2016).

- Effect of the interaction:

The interaction between potassium rates, bio and foliar fertilization on the fresh shoots, roots weight and sugar yield of sugar beet was high significant during the two seasons except the first season of shoots fresh weight of sugar beet (Fig 2).

The maximum values of fresh shoots, roots weight and sugar yield obtained under 48 kg K_2O fed^{-1} and boron fertilizers treatment in both seasons.

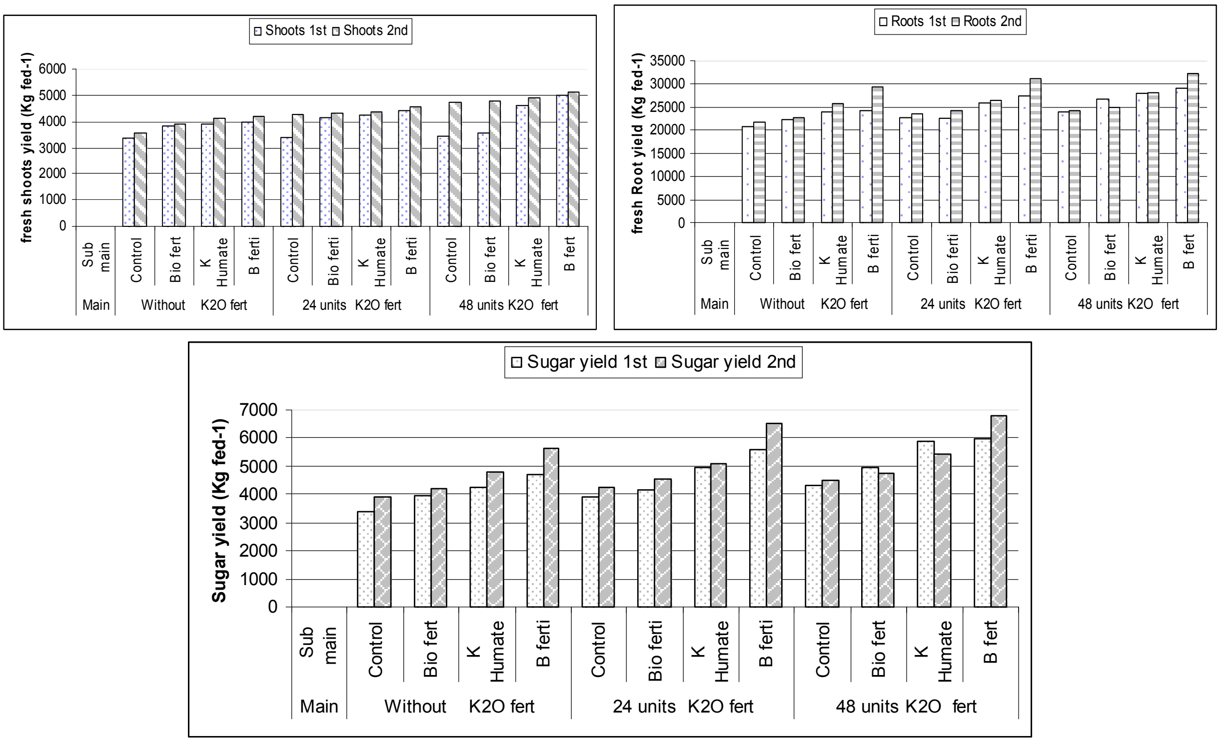

Fig. 2. Effect of interaction between potassium rates, bio and foliar fertilization on fresh shoots, roots and sugar yield Kg fed^{-1} at harvest stage during 1st. and 2 nd seasons.

2- Nitrogen, K and Na, sugar and quality concentration of sugar beet roots.

Nitrogen, K, Na, sugar and quality concentrations (%) of sugar beet roots as affected by potassium rates, bio and foliar fertilization at harvest stage during the two seasons 2014-2015 and 2015-2016 are shown in Table 3.

- Effect of potassium fertilization:

Data in Table 3 show that high significantly affected by potassium fertilization used. Nitrogen and potassium % and sugar and quality% in sugar beet roots increased in the last stages in both seasons. The maximum concentration in roots (3.79 and 4.02) N%, (7.04 and 7.38) K%, (19.50 and 19.48) sugar% and (79.89 and 81.69) quality % compared to the control. While sodium % decreased with increasing potassium fertilization. These results could be supported by those obtained by Brar *et al*., (2015) and Nowar *et al*., (2016).

- Effect of bio fertilization:

Data in Table 3 show that high significantly affected by bio fertilization. Table 3 reveals that mean values of N and K concentration in root tended to increase in the dry matter of all stages due to biofertilizer this may be due to increase available K in the root zone, where the highest mean values of plants with biofertilizer (3.58 and 3.63) N% and (7.06 and 7.32) K % and (18.87 and 19.38) sugar% and (78.62 and 81.43) quality % in the harvest stage in both seasons compared to (3.53 and 3.41) N% (6.26 and 6.62) K%, (17.16 and 18.26) sugar % and (76.92 and 78.96) quality% in plants without biofertilizer, while Na had the lowest values concentration (1.18 and 1.32)% compared with (1.99 and 1.92)% in the control. These results are confirmed with Agamy *et al*., (2013).

Table 3. Nitrogen, K, Na, sugar and quality concentrations (%) of sugar beet roots as affected by potassium rates, bio and foliar fertilization at harvest stage during 2014/15 and 2015/16 seasons.

Treatments	N, K, Na, sugar and quality concentration of Sugar beet roots at harvest stage									
	N %		K %		Na %		Sugar %		Quality %	
	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season
Without K_2O fert	3.66	3.56	6.36	7.14	1.98	1.91	17.76	18.70	78.44	80.63
24 units K_2O fert	3.73	3.71	6.65	7.29	1.68	1.71	18.78	19.25	78.69	81.09
48 units K_2O fert	3.79	4.02	7.04	7.38	1.53	1.46	19.50	19.48	79.89	81.69
F. test	*	*	*	*	*	*	*	*	*	*
LSD at 0.05	0.08	0.10	0.01	0.01	0.01	0.01	0.05	0.11	0.16	0.08
Control	3.53	3.40	6.26	6.62	2.14	2.02	17.16	18.26	76.91	78.96
Bio fert	3.58	3.63	6.77	7.29	1.84	1.77	18.32	18.76	78.51	80.79
K Humate	3.67	3.80	6.90	7.54	1.78	1.68	19.22	19.09	79.91	81.58
B fert	4.12	4.21	6.80	7.63	1.17	1.32	20.02	20.48	80.70	83.22
F. test	*	*	*	*	*	*	*	*	*	*
LSD at 0.05	0.11	0.10	0.01	0.01	0.01	0.01	0.11	0.09	0.09	0.09

- Effect of humate potassium:

Data in Table 3 show that high significantly affected by humate potassium fertilization. Humate potassium affected N, K, Na, sugar and quality concentration, values of N and K, sugar and quality concentration were (3.68 and 3.81) %N and (6.77 and 7.27) %K, (18.32 and 18.76) sugar % and (78.51 and 80.79) quality % compared with (3.53 and 3.40) %N and (6.26 and 6.62) %K and (17.16 and 18.26) sugar % and (76.92 and 78.96) quality% in the control.

- Effect of boron fertilization:

Data in Table 3 show that high significantly affected by boron fertilization.

The maximum concentration in roots (4.12 and 4.21) N%, (6.80 and 7.63) K%, (20.02 and 20.48) sugar % and (80.70 and 83.22) quality% during both seasons compared with the control. While values of sodium concentration decrease under boron foliar fertilization, this may be due to role of boron in sodium assimilation (Kanay *et al*., 2009), Abdallah and Mekdad (2015) and Abdel-Motagally (2015).

- Effect of the interaction:

The interaction between potassium rates, bio and foliar fertilization on N, K, Na, sugar and quality concentration of sugar beet roots was high significant during the two seasons except the first season of N % of sugar beet roots insignificant (Table 4).

Regarding the effect of potassium fertilization, biofertilizer and foliar fertilization (K humate and boron), data in Table 4 show that the highest values of N and K in the harvest stage of (4.23 and 4.51) and (7.12 and 7.67) % at first and second seasons were obtained with 48 kg K2O of potassium fertilization dose with B fertilization compared to (3.45 and 3.09) and (5.45 and 6.27) % of the harvest stage of the control in first and second season. On the other hand, As shown in the tables, the effect of 48 kg K2O of potassium fertilization dose with B fertilization on Na % of roots is positive where Na content of roots were decreased with increasing K rates with all sub treatments compared to the control. Figure 3: illustrates the relationship between K%, Na% and sucrose % in roots where that the increase in potassium fertilizer decreased of Na % in roots, while increased of sucrose %. The highest values of sucrose and quality in the harvest stage of (20.45 and 21.00) and (81.62 and 83.33) % at first second seasons were obtained with 48 kg K2O of potassium fertilization dose with B fertilization compared to (16.07 and 17.98) and (76.35 and 77.97) % of the harvest stage of the control in first and second season.

3-Boron concentration of sugar beet.

Data in Table 5 display the effect of potassium rates, bio and foliar fertilization on boron concentration (ppm) in sugar beet shoots at different growth stages in the two seasons.

- Effect of potassium fertilization:

Data in Table 5 show that the B concentration (ppm) of shoots high significantly affected by potassium fertilization used, where the highest mean values of (33.70 and 34.11) ppm in shoots of 1st stages at both seasons compared to (31.63 and 32.32) ppm of control.

In general increasing potassium fertilization levels led to clear increase of boron concentration of sugar beet shoots. It is worth to be mentioned B concentration mg kg^{-1} decreased at the late age (Fig 4). These results are confirmed with Zengin *et al*., (2009) and Brar *et al*., (2015).

Table 4. Nitrogen, K, Na, sucrose and quality concentrations (%) of sugar beet roots as affected by the interaction between potassium rates, bio and foliar fertilization at harvest stage during 2014/15 and 2015/16 seasons.

N, K, Na, sucrose and quality concentration of Sugar beet roots at harvest stage											
Treatments		N %		K %		Na %		sucrose %		Quality %	
A Main	B Sub main	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season
Without K_2O fert	Control	3.45	3.09	5.45	6.27	2.42	2.28	16.07	17.98	76.35	77.97
	Bio fert	3.58	3.44	6.39	7.13	2.12	1.88	17.87	18.50	77.45	80.37
	K Humate	3.59	3.70	6.52	7.56	2.11	1.79	17.79	18.72	79.79	81.10
	B ferti	4.03	4.01	7.11	7.61	1.29	1.72	19.33	19.62	80.20	83.11
24 units K_2O fert	Control	3.57	3.45	6.39	6.77	2.16	2.11	17.45	18.20	76.50	79.15
	Bio ferti	3.58	3.51	6.95	7.22	1.77	1.83	18.45	18.80	78.12	80.70
	K Humate	3.66	3.76	7.07	7.57	1.66	1.71	18.96	19.20	79.86	81.30
	B ferti	4.12	4.13	6.19	7.62	1.16	1.22	20.29	20.83	80.30	83.23
48 units K_2O fert	Control	3.58	3.68	6.95	6.83	1.85	1.68	17.97	18.60	77.90	79.77
	Bio fert	3.60	3.94	6.98	7.52	1.64	1.62	18.66	18.98	79.97	81.30
	K Humate	3.78	3.96	7.11	7.50	1.58	1.55	20.93	19.35	80.10	82.36
	B fert	4.23	4.51	7.12	7.67	1.08	1.02	20.45	21.00	81.62	83.33
A*B	F. test	N.S	*	*	*	*	*	*	*	*	*
	LSD at 0.05	-	0.17	0.02	0.02	0.03	0.02	0.19	0.15	0.16	0.16

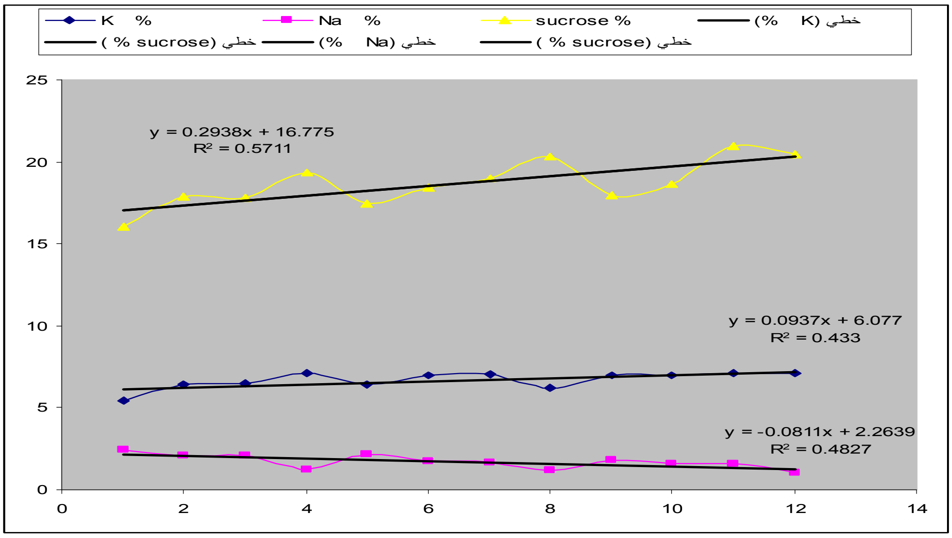

Fig. 3. Relations between K %, Na % and sucrose% of sugar beet plants.

Table 5. B concentration (ppm) of sugar beet shoots as affected by potassium rates, bio and foliar fertilization at different growth stages during 2014/15 and 2015/16 seasons.

Treatments	B ppm (Shoots)					
	After 120 days from sowing		After 150 days from sowing		After 180 days from sowing	
	First season	Second season	First season	Second season	First season	Second season
Without K_2O fert	31.63	32.32	30.55	31.60	30.08	30.48
24 units K_2O fert	32.51	33.00	31.58	32.07	30.71	31.11
48 units K_2O fert	33.70	34.11	32.85	33.24	29.63	31.78
F. test	*	*	*	*	*	*
LSD at 0.05	0.04	0.05	0.02	0.01	0.04	0.06
Control	30.82	31.06	30.01	30.46	29.47	29.60
Bio fert	32.17	32.56	31.10	31.50	30.40	30.49
K Humate	33.01	33.53	31.78	32.65	30.89	31.36
B fert	34.46	35.43	33.74	34.60	29.80	33.05
F. test	*	*	*	*	*	*
LSD at 0.05	0.03	0.04	0.01	0.01	0.02	0.04

- Effect of bio fertilization:

Table 5 reveals that values of B concentration in shoot tended to increase in the dry matter of all stages due to K fertilizer, where the highest mean values of plants with biofertilizer (32.17 and 32.56) ppm in the first stage in both seasons compared to (30.82 and 31.06) ppm in plants without biofertilizer.

These results could be supported with Hashemi *et al*., (2014) and Sayed-Ahmed *et al*., (2016).

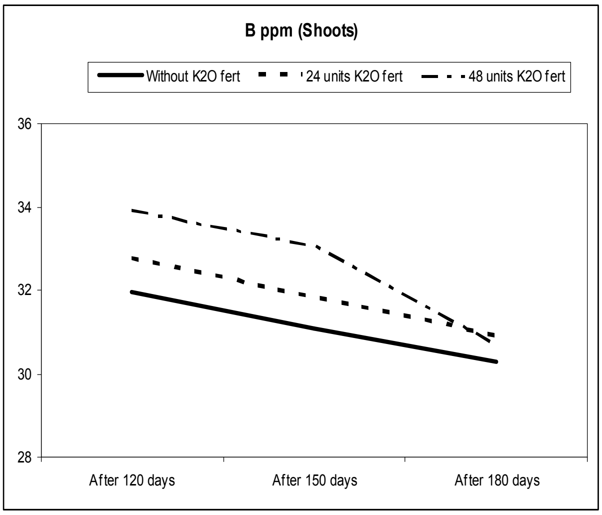

Fig. 4. Changes of B concentration mg kg-1 with variants during shoots age

- Effect of humate potassium:

Data in Table 5 show that high significantly affected by humate potassium fertilization. The highest values of B concentration were (33.01 and 33.53) ppm with K-humate compared with (30.82 and 31.06) ppm in the control.

- Effect of boron fertilization:

Boron fertilization as foliar application has a significant effect on B concentration at 1st, 2nd and 3rd stages in both seasons. The maximum concentration in shoots (34.46 and 35.43) ppm after 120 days from sowing at first and second season, these results from applying foliar boron fertilization. On contrary, the control treatment (without boron fertilization) has the minimum concentration (30.82 and 31.06) ppm.

These results are confirmed with those obtained by Abo-Steet *et al.,* (2015) and Masri and Hamza (2015).

- Effect of the interaction:

Regarding the effect of potassium rates, bio and foliar fertilization interaction, (Table 6) show that the highest values in the first, second and third stages of (35.61, 34.89 and 24.70) ppm in the first season and (36.54, 35.80 and 34.03) ppm in the second season were obtained with 48 kg K_2O fed^{-1} and boron foliar application.

Table 6. B concentration (ppm) of sugar beet shoots as affected by the interaction between potassium rates, bio and foliar fertilization at different growth stages during 2014/15 and 2015/16 seasons.

Treatments		B ppm (Shoots)					
A	B	After 120 days from sowing		After 150 days from sowing		After 180 days from sowing	
Main	Sub main	First season	Second season	First season	Second season	First season	Second season
Without K_2O fert	Control	30.03	30.28	29.08	30.00	29.03	29.50
	Bio fert	31.18	31.91	29.87	30.87	29.45	29.89
	K Humate	32.11	32.55	30.35	31.65	30.00	30.45
	B ferti	33.23	34.54	32.90	33.88	31.85	32.10
24units K_2O fert	Control	31.12	31.42	30.45	30.50	29.50	29.80
	Bio ferti	31.59	31.89	30.89	30.98	29.98	30.03
	K Humate	32.81	33.50	31.55	32.70	30.50	31.60
	B ferti	34.54	35.22	33.45	34.12	32.87	33.03
48 units K_2O fert	Control	31.33	31.50	30.50	30.90	29.90	29.50
	Bio fert	33.76	33.88	32.56	32.67	31.78	31.57
	K Humate	34.12	34.55	33.45	33.60	32.17	32.03
	B fert	35.61	36.54	34.89	35.80	24.70	34.03
A*B	F. test	*	*	*	*	*	*
	LSD at 0.05	0.05	0.06	0.03	0.02	0.04	0.07

CONCLUSION

Under the experimental conditions the best treatment to obtain the highest sugar beet growth, yield and quality was 48 kg K_2O fed^{-1} in addition to boron fertilization.

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إستجابة المحتوى الكيميائي ومحصول بنجر السكر لإضافة أسمدة البوتاسيوم المعدنية والحيوية والتسميد الورقى بالبورون

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تم تنفيذ تجربة حقلية في مركز بلقاس بمحافظة الدقهلية مصر خلال الموسمين المتعاقبين 2014-2015 و 2015-2016 لدراسة تأثير تسميد البوتاسيوم المعدنى والحيوى والرش بهيومات البوتاسيوم والبورون علي المحصول والجودة لبنجر السكر. استخدم تصميم القطع المنشقة مره واحدة فى ثلاث مكررات , وشغلت القطع الرئيسيه التسميد البوتاسى الأرضى فى صورة سلفات بوتاسيوم 48% K_2O : 1- بدون تسميد بوتاسى 2- 24 وحدة من التسميد البوتاسى 3- 48 وحدة من السماد البوتاسى الأرضى. وشغلت القطع الشقية بأربعة مستويات: 1- بدون اضافة السماد الحيوي وبدون إضافة السماد الورقى. 2- اضافة السماد الحيوي (السماد الحيوي عبارة عن بكتريا مذيبة للبوتاسيوم مثل *Bacillus circulans*) 3- التسميد الورقى المضاف رشا بهيومات البوتاسيوم بمعدل 1 لتر للفدان. 4- التسميد الورقى المضاف رشا بالبورون بمعدل 1 لتر للفدان. وفيما يلي عرض لملخص النتائج المتحصل عليها:- أظهرت النتائج أن أعلى قيم لمحصول النبات اخضر ومحصول جذور بنجر السكر و محصول السكر بالكيلوجرام للفدان كانت مع المعاملة 48 وحدة بوتاسيوم أرضى وذلك مع التسميد بالبورون رشا بمعدل 1 لتر للفدان على ثلاث فترات بعد 30 , 60 و 90 يوم من الزراعة فى الموسم الثانى من الزراعة بينما كانت أقل القيم لمحصول المجموع الخضرى والجذور ومحصول السكر مع المعاملة بدون سماد بوتاسى وبدون التسميد بالبورون.- كما كانت أعلي قيم لتركيز النيتروجين والبوتاسيوم والسكر والجودة فى المجموع الجذري فى الموسم الثانى من الزراعة عنه فى الموسم الأول و ذلك مع إضافة 48 وحدة بوتاسيوم أرضى وذلك مع التسميد بالبورون رشا بينما أعلي قيم للصوديوم فى المجموع الجذري كانت مع الكنترول.- كما كانت أعلي قيم لتركيز البورون فى المجموع الخضرى كانت مع المعاملة 48 وحدة بوتاسيوم أرضى وذلك مع التسميد بالبورون رشا بمعدل 1 لتر للفدان على ثلاث فترات بعد 30 , 60 و 90 يوم من الزراعة فى الموسم الثانى (بعد 120 يوم من الزراعة) بينما كانت أقل القيم مع المعاملة بدون سماد بوتاسى وبدون التسميد بالبورون.