Effect of Boron, Potassium and Calcium on Growth, Yield and Quality of Two Sugar Beet Varieties under Sandy Soil Conditions

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ABSTRACT

Two field experiments were carried out at Wadi El-Noran Farm, Al-Abtal Village, Eastern Suez Canal, Ismailia Governorate (latitude of 30^0 18 N and longitude of 32^0 30 E) in 2013/2014 and 2014/2015 seasons to evaluate the performance of two mono-germ sugar beet varieties namely Nancy and Karim (*Beta vulgaris* var. *saccharifera* L.), as affected by the applications of boron, potassium and calcium fertilization whither as single element application or as a mixture of the three elements on growth, yield and quality of sugar beet under sandy soil settings. The treatments were arranged in split plots design with four replicates where varieties were arranged in main plots and the mineral spray applications were arranged in sub-plots. The present work included ten treatments represent the interactions between the two sugar beet varieties and five combinations of three elements including the following: 1. without application of elements (control), 2. Application of 150 ppm boron/fed (as boric acid 17% boron), 3. Application of 2 L potassium/fed (as potassien-P compound including 30% K_2O + 8% P_2O_5/l), 4. Application of one liter of calcium/fed as form of compound Calso-x (8% chelated calcium as calcium carbamide, claw on humic acid 10% and free amino acid 3%), 5. Application of the combination of (potassium + boron + calcium) at the previously mentioned levels. The fertilization treatments were given as foliar application/400 liter water/fed, Results indicated that Karim variety had the highest values in Leaf area index, root and foliage fresh weighs (g/plant), total dry weight (g/plant), as well as root and extracted sugar yields(t/fed). Meantime, Nancy had surpassed Karim in sucrose%, extracted sugar% and quality index%.Foliar application of sole and combined applications of the three elements was significantly affected in leaf area index, root and foliage fresh weighs g/plant, and total dray weight g/plant compared to untreated. Fertilizing sugar beet by mixture of potassium +Boron + Calcium recorded a important increase in root and extracted sugar yields/fed and sucrose% as compared to untreated. Karim variety achieved the highest value of extracted sugar yield/fed when treated by mixture application of (B, K and Ca) while, untreated Nancy variety gave the lowest value. It could be recommend that fertilizing Karim variety by mixture of 150 ppm B+ 2 L potassien-P + one L Ca/400 L water/fed as foliar application to get the maximum of root and sugar yields/fed under this experimental conditions.

Keywords: Sugar beet varieties, boron, Potassum, calcium , sandy soil.

INTRODUCTION

Some experiments were previously conducted in similar areas of sandy soil to find out the recommended levels of each of calcium, boron and potassium elements for sugar beet. Meantime, soil analysis of the present experimental site showed that the available content of any of these nutrients was below the critical level. Therefore, it was necessary to apply the recommended dose of them separately and/or in combinations to study the functional integration of these elements, aiming at reaching the highest root and sugar yields as well as the best quality characteristics.

In Egypt, All sugar beet varieties which cultivated are import from European countries. So, it is favorable to evaluate their performance under the Egyptian conditions, especially in different soil. In this respect, Hozayn *et al*. (2013) evaluated twelve sugar beet varieties in Nubaryia district in Egypt. They concluded that Heliospoly variety gave the highest root yield/fed, sugar recovery% and sugar yield/fed, while the poorest variety was Monte Rosa. Moreover, cleared that individual variability of different varieties might be attributed to their genetic constituents and their capacity to benefit from the environmental factors, which enable them to acclimatize and attain better yield and quality parameters under newly reclaimed soil. Aly *et al.* (2015) found that sugar beet varieties (Top, Sultan and Kawemira) significantly differed in root length and diameter and root fresh weight g/plant, as will as sucrose%, quality index% and yields of root and sugar tons/fed. Enan *et al*. (2016) found that Polat variety surpassed Natoura and Henrike varieties which recorded the highest values of root diameter, fresh and top weights/plant and top yield/fed as well as dry weights percentages of roots and leaves. Also, indicated that there were insignificant differences among varieties in their impact on gross and corrected sugar yields/fed.

Boron plays important functions in sugar beet as maintaining the balance between sugar and starch; translocation of sugar and carbohydrates, standard cell division, nitrogen metabolism and protein formation, and cell wall configuration (Kobayashi *et al*., 2004). Also, it plays a main roles in the correct function of cell membranes and the transport of K^+ to guard cells to the internal water balance control system (Camacho and Gonzalez, 2007). In this respect, Kristek and Kristek (2006) found that foliar application by 1 kg boron/ha increased root yield by 13.6 t/ha (19.4%), sugar concentration by 1.46% and sugar yield by 3.15 t/ha (39.5%) as compared with the non-treated plants. Also, they recommended foliar application with 1.0 kg B/ha for sugar beet grown in soils characterized by insufficient boron supply. Dordas *et al*. (2007) reported that spraying 0.5 kg B/ha increased concentration of B in leaves of sugar beet and led to the best quality and yields. Armin and Asgharipour (2012) observed that increasing boron application led to decreases in K, Na and α-amino-N as compared with those of the control. Enan *et al*. (2011) found that higher values of root diameter, root fresh weight/plant and yields of root, top and sugar tons/fed and sucrose% were obtained with spraying boron at 100 ppm.

Potassium plays some important regulatory roles in plant development; it has considerable effect on protein synthesis, stomatal regulation, enzyme activation, water-relation and photosynthesis in plants

(Cakmak, 2005). It has a critical role in the transfer of sucrose to storage root. Milford *et al*. (2000) mentioned that an increase in recoverable sugar yields might be due to the role of K in nutrients uptake and nutritional balance, which increase the biosynthesis of photosynthetic. When sugar beet plants suffer from the deficiency of K, translocation of photosynthetic from leaves to roots reduced resulting in less industrial sugar production (Hermans *et al*. 2006). In addition, Enan (2011) indicated that application of 24 kg K_2O/fed + two sprays of potassien-p significantly resulted in the highest values of root diameter, root and top fresh weight, root and sugar yields/fed, quality and sucrose% compared to the other potassium treatment. Mehran and Samad (2013) showed that increasing K rates considerably increased root fresh weight/plant, root and sugar yields/fed. Aly *et al*. (2014) found that the applied potassium treatments either as soil or foliar significantly increased diameter and fresh weight/plant, sucrose%, sugar extracted%, quality index as well as root and recoverable sugar yields/fed and reduced Na root content, while increased K in roots in comparison to the control. Enan *et al*. (2016) found that foliar use of 2 L potassien-P compound significantly improved LAI, root diameter, root and top fresh weights/plant, root and top dry weights%, sucrose%, corrected sugar%, quality index, root and sugar yields/fed,whereas reduced Na and alpha amino-N contents under sandy soil conditions.

Calcium is an important element in many physiological processes and is believed to act as a second messenger in plant cells, where it represented in coupling a wide range of extra cellular. On the other hand, calcium and potassium ions are quite similar in size and charge and hence, exchange sites can't distinguish the difference between the ions. Moreover the rate of potassium uptake is also influenced by high soil pH, where further calcium and potassium compete with each other and the addition of any one of them will reduce the uptake rate of the other two elements (Christenson and Draycott, 2006). Artyszak *et al*. (2014) found that foliar application of sugar beet with 262.0 g Ca/ha in the stage of 4-6 leaves led to increases of the root yield by 13.1%, leaf yield by 21.0%; sugar yield by 15.5% and yield of sugar by 17.7% as well as significant reduction of α-amino-N content and tended to reduce the content of K and Na. Enan (2015) indicated that increasing calcium application up to 288 ppm/fed resulted in higher values of root diameter, roots and foliage fresh weights g/plant and yields of roots and recoverable sugar tons/fed. The similar trend resulted in sucrose and sugar recovery percentages. A foliar supplement of Ca combined with B significantly enhanced root and sugar yields of sugar beet (Singh *et al*., 2002). Awasthi and Lal (2009) noticed that boron and calcium plays important roles in sugar accumulation in many plants. Many causal factors may obtain the variability in B/Ca effectiveness, including soil B/Ca availability and developmental phases of the plant. Also Boron and potassium have overlapping roles to play in plant physiology and consequently, are synergistic. It has been shown that an optimal level of boron increases potassium permeability in the cell membrane.

The plan of this study was to evaluate the performance of two mono-germ sugar beet varieties grown in a sandy soil as affected by different foliar individually and/or in combinations of recommended dose of boron, potassium and calcium and their potential on growth, yield and quality traits under this conditions.

MATERIALS AND METHODS

Two field experiments were carried out at Wadi El-Noran Farm, Al-Abtal Village, Eastern Suez Canal, Ismailia Governorate (latitude of 30^0 18^- N and longitude of 32^0 30^- E) in 2013/2014 and 2014/2015 seasons to evaluate the performance of two mono-germ sugar beet varieties namely Nancy and Karim (*Beta vulgaris* var. *saccharifera* L.) imported from (Denmark and Nederland) in respect to growth, yield and quality as affected by the application of different foliar combinations of recommended levels of boron, potassium and calcium under sandy soil conditions. The present work included ten treatments represent the interactions between the two sugar beet varieties and five combinations of three elements including the following:

1. without application of elements (control),
2. Application of 150ppm boron/fed (as boric acid17% boron),
3. Application of 2 L potassium/fed (as potassien-P compound including 30% K_2O + 8% P_2O_5/L),
4. Application of 1 liter of calcium/fed as form of compound Calso-x(8% chelated calcium as calcium carbamide, claw on humic acid 10% and free amino acid 3%)
5. Application of the combination of (potassium+ boron+ calcium) at the previously mentioned levels. The fertilization treatments were given as foliar application/400 liter water/fed, which were sprayed twice at 4-6 and 6-8 leaf stage later. The treatments were arranged in split plots design with four replicates. The sub plot area was 21.60 m^2 involved 12 rows of 4 m in length and 45 cm in width with 17 cm between hills. The two sugar beet varieties were distributed in the main plots and the five nutrition treatments were randomly distributed in the sub plots. The two sugar beet varieties sown mechanically in the 1st week of September, while harvesting was done 7 months later in both seasons.

Phosphorus fertilizer was applied in the form of calcium super phosphate (15% P_2O_5) by rating of 200 kg/fed at seed bed preparation. Nitrogen fertilizer was applied as ammonium nitrate (33.5% N) at the rate of 120 kg N/fed, which was split into 14 doses, weekly applies as fertigation through the *central pivot* system, where the 1st one was applied at 14 days after sowing.

Potassium fertilizer was applied after 60 days from sowing at the rate of 48 kg/fed in the form of potassium sulfate (48% K_2O). Soil samples were taken before sowing at random from every location area at a depth 0-30 cm from soil surface and prepared for mechanical and chemical analysis, according to Piper (1955) as shown in Table 1.

Table 1. Particle size distribution and some chemical properties of the soil of the experimental site in 2013/2014 and 2014/2015 seasons

2013/2014											
Particle size			**Soil textural**		**Ec (dSm^{-1})**		**Soil pH (1:2.5)**			**Organic matter %**	**SP**
Sand%	**Silt%**	**Clay%**									
91.10	6.98	1.92	Sandy		4.84		7.63			1.16	19.5
Soluble cations (mq l^{-1})				Soluble ions (mq l^{-1})				Available nutrients (mg/1kg soil)			
Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Co_3^{-}	Hco_3^{-}	Cl-	So_4^{-}	N	P	K	B
9.50	15.5	20.63	2.75	-	7.5	35.5	5.38	38.9	2.24	97.5	0.43
2014/2015											
Particle size			Soil textural		Ec (dSm^{-1})		Soil pH (1:2.5)			Organic matter %	SP
Sand%	Silt%	Clay%									
91.10	6.98	1.92	sandy		4.50		7.80			1.20	20.1
Soluble cations (mq l^{-1})				Soluble ions (mq l^{-1})				Available nutrients (mg/1kg soil)			
Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Co_3^{-}	Hco_3^{-}	Cl-	So_4^{-}	N	P	K	B
8.00	14.3	19.60	2.90	-	6.20	34.05	4.55	40.0	2.45	105.4	0.41

The recorded data:

1. **Leaf area index (LAI):** Leaf area was measured using "the disk method" according to Watson (1958) and LAI was calculated at 120 days from sowing as the following equation:

LAI = leaf area per plant (cm^2)/plant ground area (cm^2).

At harvest, a sample of ten plants was randomly collected from each of sub-plots to determine the following traits:

2. Root diameter (cm).
3. Root fresh weight (g/plant).
4. Foliage fresh weight (g/plant)
5. Total dry weight (g/plant) = [root dry matter% x root fresh weight (g) + top dry matter% x top fresh weight (g)], where represented samples of 100 g of both root and top fresh weights were oven dried for 48 hours at 70^0 C to a constant weight; then, root and top dry matter% of each of them were estimated.

Juice quality and chemical constituents:

The following quality traits were determined in the Quality Control Laboratory at Alexandria Sugar Factory, Alexandria, Egypt.

1. Sucrose % (Pol %), which was estimated in fresh samples of sugar beet roots, using "Saccharometer" according to the method described in A.O.A.C. (2005).
2. Extracted sugar%, which was calculated using the following equation according to the following equation of Cooke and Scott (1993): Extracted sugar% = Pol % - 0.343*(K + Na) – α-amino N* (0.0939) – 0.29
3. Sugar lost to molasses% (SLM) = sucrose% - extracted sugar% - 0.6.
4. Juice quality index (QI % = Purity %) was calculated using the following equation of Cooke and Scott (1993): QI% = Extracted sugar%x100/pol%
5. Impurities (α-amino N, Na and K contents in juice) were estimated as meq/100 g beet according to the procedures of Sugar Company by Automated Analyzer as described by Cooke and Scott (1993).

At harvest, plants of two guarded rows were counted, uprooted, topped and weighed to determine the following parameters:

1. Root yield (t/fed).
2. Extracted sugar yield (t/fed), which was calculated according to following equation: Extracted sugar yield (t/fed) = root yield (t/fed) x extracted sugar%.

The collected data were statistically analyzed as shown by Gomez and Gomez (1984). Treatments means were compared using by Duncun (1955) at 5% level of probability. All statistical analysis of variance was performed using technique of (MSTAT-c) computer software package.

RESULTS AND DISCUSSION

Data in Table 2 show that the differences between the two sugar beet varieties in all mentioned traits were significantly increased in both seasons. Karim variety recorded the highest values of these traits, where it had pronounced increment in total dry weight (TDW) amounted 19.8 and 31.6 g/plant in the first and second seasons as compared to Nancy variety, respectively. The variance between the two tested sugar beet varieties in this trait may be due to superior of Karim variety in leaf area index (LAI), root fresh weight (RFW) and foliage fresh weight (FFW) traits which it basically was related to their gene make-up action that plays important roles in plant structure and morphology. This observation coincide with those found by Enan (2011) and Hozayn *et al.,* (2013).

LAI, RFW, FFW, root diameter and TDW were significantly affected by the sole and combined applications of the used elements in both seasons (Table 2). Regarding the effect of individual element, it was found that fertilizing sugar beet plants with boron, potassium and calcium individually, produced heavier RFW and FFW and TDW consequently increased as compared to untreated plants. On the other hand, fertilizing beets with a mixture of each of the three elements (B, K and Ca) resulted in a positive effect on these traits. These results may be due to the shortage of Boron, potassium and calcium in the soil of experimental site (Table 1). Therefore, the important roles of Boron, potassium and calcium on root dimension and foliage development could be attributed to the stimulant effect on rate of photosynthesis through carbohydrate metabolism and transport of the photosynthetic product from the leaves to the storage root. These results may be due to that foliar application by 1 L Ca/fed significantly increased LAI, RFW and FFW which may be increased the photosynthetic surface per unit area which consequently, promoted growth and nutrient uptake of plants by addition of potassium which affects membrane permeability. On the other hand, LAI reduced by unfertilized with elements. These results are in agreement with Singh *et al*. (2002); Awasthi and Lal (2009); Artyszak *et al*. (2014) and Enan (2015).

Table 2. Leaf area index (LAI), root fresh weight g/plant (RFW), foliage fresh weight g/plant (FFW), root diameter and total dry weight g/plant (TDW) for the two sugar beet varieties as affected by the sole and combined application of boron, potassium and calcium in 2013/2014 and 2014/2015 seasons.

Characters	LAI		RFW		FFW		Root diameter (cm)		TDW	
Treatments	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15
					Varieties (V)					
Nancy	3.38b	3.37b	903b	922b	236b	248b	11.02b	11.08b	217.4b	229.3b
Karim	3.59a	3.56a	944a	966a	270a	282a	11.56a	11.71a	237.2a	250.9a
F. test	*	*	*	*	*	*	*	*	*	*
					Elements foliar (E)					
T1: control	3.28c	3.21c	849e	873d	235c	248d	10.65c	10.57d	188.7c	202.9d
T2:150 ppm Boron	3.31bc	3.37b	931c	957b	249b	258c	11.53ab	11.77ab	233.1b	247.5b
T3:2 L K/fed	3.57ab	3.53a	944b	967b	252b	267bc	11.18b	11.28c	235.4b	247.4b
T4:1 L Ca/fed	3.59ab	3.56a	920d	936c	263a	275ab	11.38ab	11.50bc	228.9b	239.7c
T5:Boron+K+Ca	3.65a	3.67a	972a	986a	265a	278a	11.70a	11.87a	250.2a	263.0a
V x E	NS	NS	*	NS	NS	NS	NS	NS	NS	NS

Means with the same letter in each column, on the basis of Duncan test, have no significant differences at 0.05 level.

Data in Table 3 show that differences between the tested sugar beet varieties were significant in their effect on root yield, sucrose% and α -amino N in both seasons except, K was insignificant in the second season and Na in both seasons. Karim variety recorded the higher value in root yield and the lowest in α -amino N traits in both seasons. Whereas, Nancy surpassed Karim in sucrose% in both seasons, as well as in the 1st season for potassium. Varietal difference between the two tested sugar beet varieties may be attributed to their gens structure. These results are in harmony with those obtained by Hozayn *et al*. (2013) and Enan *et al*. (2016). In the same Table results obtained that sugar beet fertilizing mixture with potassium +Boron + Calcium recorded a significantly increased in root yield and sucrose% in both seasons as compared to untreated. Inversely, underutilizing sugar beet significantly declined in juice impurities compared to that foliated by 1 L Ca/fed. The positive influence of the mixture application of the three elements as compared to individual element may be due to the shortage of them in the soil sample of the experimental site (Table 2). Hence, the important role of potassium on root yield could be attributed to the stimulatory effect of potassium on photosynthesis rate through carbohydrate metabolism and transport of the photosynthetic product from the leaves to the storage root which reflects on root and sugar yields. These results are in agreement with those recorded by Camacho-Cristóbal and Gonzalez-Fontes (2007);Awasthi and Lal (2009) and Enan (2011).

Table 3. Root yield (t/fed), juice impurities (K, Na and α -amino N) and sucrose% for the two sugar beet varieties as affected by and the sole or/and combined foliar application of boron, potassium and calcium in 2013/2014 and 2014/2015 seasons.

Characters Treatments	Root yield (t/fed)		Impurities (meq./100 beet)						Sucrose%	
			K		Na		α -amino N			
	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15
					Varieties (V)					
Nancy	30.93b	31.91b	3.82a	3.86	1.48	1.45	0.74a	0.65a	18.90a	18.73a
Karim	33.75a	33.94a	3.79b	3.89	1.52	1.49	0.63b	0.60b	18.26b	18.19b
F. test	*	*	*	NS	NS	NS	*	*	*	*
					Elements foliar (E)					
T1: control	31.79c	32.20c	3.63b	3.67d	1.33b	1.36c	0.59b	0.52c	18.01c	17.86d
T2:150 ppm Boron	32.39b	33.11ab	3.85a	3.91bc	1.49a	1.41bc	0.71a	0.61b	18.74ab	18.73ab
T3:2 L K/fed	32.52ab	33.13ab	3.87a	3.96ab	1.54a	1.48ab	0.70a	0.68ab	18.53b	18.32c
T4:1 L Ca/fed	32.06bc	32.65bc	3.90a	3.99a	1.58a	1.58a	0.74a	0.72a	18.67ab	18.49bc
T5: Boron+K+Ca	32.95a	33.54a	3.78a	3.86c	1.55a	1.51ab	0.70a	0.63b	18.96a	18.91a
V x E	NS	NS	*	*	NS	NS	NS	*	NS	NS

Means with the same letter in each column, on the basis of Duncan test, have no significant difference at 0.05 level.

Data in Table 4 show that differences between Nancy and Karim varieties were significant in their affect extracted sugar% and extracted sugar yield in both seasons. Those differences between them were insignificant in their effect on Na and SLM in both seasons and K in the 2st season. Nancy variety surpassed Karim in extracted sugar% in both seasons and QI% in the 2nd season only. On the other hand, Nancy significantly decreased as compared to Karim in extracted sugar yield. These results may be correlated to the increment in sucrose% and the reduction of impurities (K and Na) for Nancy as compared to Karim variety (Table 3). Whereas, the increment in extracted sugar yield/fed of Karim variety basically due to its higher root yield/fed than Nancy (Table 2). These results are in harmony with that obtained by Hozayn *et al*. (2013) and Enan *et al*. (2016).

Regarding to the effect of foliar elements data in Table 4 show that significant differences among elements were found in the above-mentioned traits. The positive effect of beets fertilizing with mixture of potassium +Boron + Calcium compared to the individual effect for each of them. The data indicate that the complementally or synergism effect between the enhancement of potassium and boron elements in building up photosynthesis and hence root girth increased accompanied by increasing the width and extend of cambia rings and the volume baranchaima cells that it's store of sugar and reflecting increase in sugar yield/fed. This observation coincide with those found by Christa *et al*. (2011).

Table 4. The percentages of the extracted sugar, sugar lost to molasses (SLM) and quality index% (QI) and Extracted sugar yield (t/fed) for the two sugar beet varieties as affected by the two sugar beet varieties and the sole and combined application of boron, potassium and calcium used in 2013/2014 and 2014/2015 seasons.

Characters	Extracted sugar%		SLM%		QI%		Extracted sugar yield (t/fed)	
Treatments	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15
				Varieties (V)				
Nancy	16.88a	16.72a	1.43	1.41	89.27	89.28a	5.22b	5.34b
Karim	16.26b	16.19b	1.40	1.41	89.04	88.98b	5.49a	5.49a
F. test	*	*	NS	NS	NS	*	*	*
				Elements foliar (E)				
T1: control	16.07c	15.93d	1.34b	1.33c	89.21ab	89.17ab	5.10c	5.13d
T2:150 ppm Boron	16.72ab	16.73ab	1.43a	1.40b	89.20ab	89.33a	5.41b	5.54b
T3:2 L K/fed	16.49b	16.29c	1.43a	1.43ab	89.04b	88.92bc	5.36b	5.40c
T4:1 L Ca/fed	16.62b	16.43bc	1.45a	1.46a	89.02b	88.86a	5.33b	5.36c
T5: Boron+K+Ca	16.94a	16.90a	1.42a	1.41b	89.33a	89.37a	5.58a	5.66a
V x E	NS	NS	NS	NS	NS	NS	*	NS

Means with the same letter in each column, on the basis of Duncan test, have no significant difference at 0.05 level.

Data in Table 5 show that RFW, FFW and extracted sugar yield t/fed in 1st season, alpha amino-N in the 2nd season and potassium in both seasons were significantly affected by the interaction between varieties and the three nutrients. Karim variety gave the highest value with foliar mixture of (B, K and Ca) as compared to untreated Nancy in RFW and extracted sugar yield. Meanwhile topdressing of Karim variety gives the highest value of FFW as compared to untreated Nancy variety. Untreated Nancy variety attained the lowest values in potassium in both seasons and alpha amino N as compared to itself which treated by 1 L Ca/fed.

Data in the same Table cleared that statistical positive response of extracted sugar yield in the 1st season by the sole and combined application of the used elements. Karim variety achieved the highest value of extracted sugar yield/fed when treated by mixture application of (B, K and Ca) while, untreated Nancy variety gave the lowest value.

Table 5. Significant interactions between varieties and foliar application by the sole and combined application of boron, potassium and calcium of root and top fresh weights g/plant (RFW and FFW), potassium, alpha amino –N and Extracted sugar yield/fed used in 2013/2014 and 2014/2015.

Varieties (V) x elements (E)		RFW	FFW	Impurities (meq/100g beet)			Extracted sugar yield (t/fed)
				K		α-amino N	
		2013/14	2013/14	2013/14	2014/15	2014/15	2013/14
Nancy	T1: control	821h	213f	3.52c	3.64de	0.50d	5.02c
	T2:150 ppm Boron	915e	239de	3.91ab	3.89b	0.57cd	5.25b
	T3:2 L K/fed	921e	225ef	3.88ab	3.88b	0.75a	5.21bc
	T4:1 L Ca/fed	897f	251cd	3.98a	4.04a	0.73ab	5.11bc
	T5: Boron+K+Ca	959bc	253cd	3.82ab	3.85bc	0.72ab	5.52a
Karim	T1: control	877g	257c	3.74b	3.70d	0.53cd	5.16bc
	T2:150 ppm Boron	946cd	260c	3.79ab	3.56e	0.65abc	5.61a
	T3:2 L K/fed	966b	279ab	3.86ab	4.03a	0.60bcd	5.51a
	T4:1 L Ca/fed	943d	275ab	3.82ab	3.74cd	0.70ab	5.55a
	T5: Boron+K+Ca	985a	277ab	3.75b	3.76cd	0.54cd	5.63a

Means with the same letter in each column, on the basis of Duncan test, have no significant difference at 0.05 level.

CONCLUSION

It could be concluded that fertilizing Karim variety by mixture of 150 ppm B+ 2 L potassien-P + one L Ca/400 L water/fed as foliar application to get the maximum of root and sugar yields/fed under this experimental conditions.

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تأثير البورون و البوتاسيوم والكالسيوم علي نمو وحاصل وجودة صنفين بنجر سكر تحت ظروف الأراضي الرملية

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أجريت تجربتان حقليتان بمزرعة وادى النوران في قرية الابطال شرق قناة السويس بمحافظة الاسماعيلية دائرة عرض (30.18° – شمالا) وخطوط طول (30.23° شرقا) خلال موسمى 2014/2013 و 2015/2014 لتقييم أداء صنفى بنجر سكر وحيدا الاجنة (نانسى وكريم) وتأثرهما بالتسميد الورقى بعناصر البورون والبوتاسيوم والكالسيوم سواء فى صورة فردية او خليط منهم على نمو وحاصل وجودة بنجر السكر تحت ظروف الأراضى الرملية. أستخدم تصميم القطع المنشقة مرة واحدة في اربعة تكرارات وتم توزيع الأصناف في القطع الرئيسية ومعاملات الرش الورقي في القطع الشقية. تحتوى هذه الدراسة على عشرة معاملات تشمل التفاعل بين صنفى من بنجر السكر مع خمسة توليفات للعناصر الثلاثة كما هو موضح: بدون معاملة (كنترول)، إضافة 150 جزء فى المليون بورون/الفدان (حامض بوريك 17% بورون)، إضافة 2 لتر بوتاسيوم /الفدان في صورة بوتاسين-ف يحتوي علي (30% بو$_2$ أ و 8% فو $_2$ أ$_5$ /لتر)، إضافة واحد لتر كالسيوم/الفدان في صورة مركب كالسيو-إكس يحتوي علي (8% كالسيوم مخلبى فى صورة كرباميد الكالسيوم محملة على حامض هيوميك 10% وأحماض أمينية حرة 3%)،إضافة مخلوط من العناصر الثلاثة (بورون + بوتاسيوم + كالسيوم) بنفس مستوياتها المشار اليها من قبل والتى تم اذبتها فى 400 لتر ماء /الفدان. وكانت النتائج كالاتى:- أشارت النتائج أن الصنف كريم أعطي أعلى القيم فى دليل مساحة الاوراق والوزن الطازج للجذور والأوراق بالجم/النبات والوزن الجاف الكلى بالجم /النبات ومحصول السكر القابل للاستخلاص بالطن/الفدان، فى حين تفوق الصنف نانسى على كريم فى نسبة السكروز ونسبة السكر المستخلص ودليل الجودة .أثرت المعاملات الفردية للعناصر الثلاثة ووالمخلوطة بينهم معنويا على دليل مساحة الأوراق والوزن الطازج للجذور والأوراق والوزن الجاف الكلى بالجم /النبات. سجل التسميد بخليط من العناصر الثلاثة عي بنجر السكر إلى زيادة معنوية فى حاصلا الجذور والسكر المستخلص بالطن/ الفدان والنسبة المئوية للسكروز مقارنة بالبجر غير المعامل.إكتسب الصنف كريم أعلي القيم في حاصل السكر المستخاص بالطن/فدان عندما رش بمخلوط من العناصر الثلاثة (بورون- بوتاسيوم – كالسيوم) ، في حين أن الصنف نانسي غير المعامل أعطي أقل القيم.وتوصي هذه الدراسة بزراعة الصنف كريم والتسميد بخليط من 150 جزء فى المليون بورون /الفدان (حامض بوريك 17% بورون) + 2 لتر/فدان بوتاسيوم (بوتاسين-ف 30% بو$_2$ ا ،8% فو $_2$ ا$_5$ /لتر) + 1 لتر/الفدان كالسيو- اكس (8% كالسيوم مخلبى فى صورة كرباميد الكالسيوم محملة على حامض هيوميك 10% واحماض امينية حرة 3%) مذابين فى 400 لتر ماء /الفدان كمعاملة رش لتعظيم الانتاجية لمحصول الجذور و السكر القابل للاستخلاص/الفدان تحت ظروف منطقة الدراسة.