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EFFECT OF FOLIAR POTASSIUM, MAGNESIUM AND BORON ON YIELD AND QUALITY OF SUGAR BEET (*Beta vulgaris,* L.)GROWING IN NEW RECLAIMED SOILS

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ABSTRACT

Tow Field Experiments were carried out at EL-Itizaz village, Samalout district, EL-Minia Governorate, Egypt during 2004/2005 and 2005/2006 seasons to study the effect of foliar with potassium, magnesium and boron individaly and combined on yield and quality of sugar beet. The experiment included 15 treatments which were the combinations of two levels from each of foliar potassium 1 and 2 Liter 36% K_2O/fed, with 5.4 and 10.8 kg $MgSo_4$/fed, boron (10 and 20 mg boric acid**/**fed) and control (foliar spray with water). These treatments were arranged in randomized complete block design with 3 replications.

The obtained results indicated that spraying beet plants with K, Mg or boron either solely or in combinations significantly increased root length, root diameter, root and foliage fresh weights per plant as well as roots, top and sugar yields/fed. The highest values of this traits resulted from the combinations between the three elements at higher concentrations. Also, foliar spray with Mg individual and the combinations between the three elements took the same trend for root/top ratio in both seasons. On the other hand, control treatment (without spraying) gave the maximum averages of sucrose and TSS percentages, while the highest values of purity% resulted from foliar spray with the combinations between K, Mg or B at lower concentrations in both seasons.

It, could be concluded that under the conditions of this study the highest roots and sugar yields can be produced by using foliar spray with the combinations.

INTRODUCTION

Recently, sugar beet crop has an important position in Egypt crop rotation as a winter crop not only in the fertile soils but also in poor, saline, alkaline and calcareous soils whereas, it could be economically grown in the newly reclaimed soils. Potassium fertilizer plays an important role in physiological processes in beet plants, where it proves juice quality and sugar yield. Also, potassium may play part in maintenance of turgor in plant cells as well as in the formation of sugar and in the enhancement of diseases resistance (Lawton and Cook, 1954). Dahdoh *et al*. (1988) showed that roots, top and sugar yields of sugar beet significantly increased with the application of potassium, Zinc and Phosphorus either added solely or in combinations. Bizlk (1993) concluded that a liquid fertilizer spray containing Kand Mg increased sugar contents. Pardo and Guadalix (1993) reported that potassium increased roots and sugar yields. Saif, Laila (2000), Esmail *et al*. (2002), Hassanin, Magde (2002), Ahmed (2005) and Esmail and Abo EL-Hamd (2007) stated that top, roots and sugar yields increased with increasing K level up to 48 kg K_2O/fed.

Magnesium content of most soils generally lies in the range of between 0.05 for sandy soils and 0.5 for clay soils. Some magnesium occurs in soil in association with organic matter, but this fraction is usually small and less than 1.0% of the total soil magnesium, (Tisdal and Nelson, 1975) and Mengel and Kirkbp, 1982). Domska (1996) found that application of 60 kg MgO/ha as soil application and foliar 2 kg MgO/ha to sugar beet plants gave the highest sugar yield and sugar content. Barlog and Grzebisz (2001) pointed out that application of 0.5 kg MgO/ha increased root yield by 9.9% as compared with control (without Mg foliar application). Ahmed (2005) reported that K and Mg either solely or in combinations as well as boron in combinations increase growth parameters (root and foliage fresh weights/plant, root length, root diameter and root/top ratio and added that greatest values of roots, top and sugar yields resulted from foliar spray by combining with Mg and B.

Sugar beet have higher requirement for boron than many ether crops, Boron may have a vital role in sugar translocation Mohmoud (1999).

Regarding the effect of boron fertilizer, Rizk *et al*. (1995) stated that application of moderate level of boron (1.0 kg B/fed) resulted in higher increase of fresh and dry weights of tops and root/plant. Mohmoud (1999) concluded that sugar yield/fed was increased by about 4.5 ton/fed by foliar boron application at the rate of 2.5 g/fed. Gezegen *et al*. (2001) showed that root yield and refined sugar yield of sugar beet were increased by treated soil and leaf with boron at 0.3 kg/ha. On the other hand, increasing rates of boron by the same methods to the soil decreased the root and refined sugar yields. Hussein (2002) showed that the higher root and sugar yields were obtained with the application of boron at 6.0 mg/k soil

This work was initiated to investigate the effect of potassium, magnesium and boron and their combinations on yield and quality of sugar beet.

MATERIALS AND METHODS

Two field experiments were conducted at EL-Itizaz village, Samalout district, EL-Minia Governorate in 2004/2005 and 2005/2006 seasons to study the effect of potassium, magnesium and boron as well as their combinations on yield and quality of sugar beet. The soil texture of the experimental site was sandy-Loam having 33.88% coarse sand, 55.92% fine sand, 4.65% silt, 5.55% clay, 0.56% organic mater, 0.14% total N, 8.1 PH, 85 ppm available N, 16 ppm available P, 128 ppm available K, 0.88 ppm total boron, 0.42 available mg^{++} (meg/100g. soil), 3.85% $CaCo_3$ and 10.3 mmoh/cm E.C.

A multigerm sugar beet cultivar Paleno was planted on October 3^{th} and 5^{th} in the first and second seasons, respectively. The experiment involved 15 treatments arranged in a randomized complete block design with three replications. The experimental basic unit area included six rides, each of 60 cm width and 4 m length occupying an area of 14.4 m^2. Spacing between hills were 20 cm. At 60 and 75 days from sowing, plants were sprayed with the following:

1. Foliar spray with distilled water (control).
2. Foliar spray with potassium at the rate of 1 Liter 36% K_2O/fed (K_1).
3. Foliar spray with potassium at the rate of 2 Liter 36% K_2O/fed (K_2).
4. Foliar spray with 0.6% $MgSO_4$ equal 5.4 Kg $MgSO_4$/fed (Mg_1).
5. Foliar spray with 1.2% $MgSO_4$ equal 10.8 Kg $MgSO_4$/fed (Mg_1).
6. Foliar spray with 10 mg L^{-1} boric acid (B_1).
7. Foliar spray with 20 mg L^{-1} boric acid (B_2).
8. Foliar spray with K_1 combined with Mg_1 and B_1.
9. Foliar spray with K_1 combined with Mg_2 and B_1.
10. Foliar spray with K_1 combined with Mg_1 and B_2.
11. Foliar spray with K_1 combined with Mg_2 and B_2.
12. Foliar spray with K_2 combined with Mg_1 and B_1.
13. Foliar spray with K_2 combined with Mg_2 and B_1.
14. Foliar spray with K_2 combined with Mg_1 and B_2.
15. Foliar spray with K_2 combined with Mg_2 and B_2.

Nitrogen fertilizer was applied at 80 kg N/fed as ammonium nitrate (33.5%N) in two equal doses, the first was added after thinning, while the second one was added one month later. Phosphate fertilizer applied at seedbed preparation at 30 kg P_2O_5 /fed as calicium super phosphate (15.5% P_2O_5). The other cultural practices done as recommended in the region.

At harvest time a sample of five plants were chosen at random from outer ridges to estimate yield components and juice quality characters as follows:

1. Root length (cm).
2. Root diameter (cm).
3. Root fresh weight/plant (g).
4. Foliage fresh weight/plant (g).
5. Root/top ratio.
6. Total soluble solids percentage (TSS%) of roots it was measured in juice of fresh root using hand refract meter.
7. Sucrose percentage (pol%) it was polarimeterically determined according to the methods of Le Docte (1927).
8. Juice Purity percentage % it was calculated according to the following.

Juice purity % = sucrose% xTSS%/100.

At harvest sugar beet plants from the two inner ridges were calculated and cleaned roots and tops were separated and weighted in kg, then converted to estimate:

1. Root yield (ton/fed).
2. Top yield (ton/fed).
3. Sugar yield ton/fed, it was computed according to the following formula.

Sugar yield = Recovery sugar x root yield /100

Recovery sugar = (S- 0.4)(B-S) x 0.73

Where S = sucrose % B = TSS%.

The obtained data of both seasons were tabulated and statistically analyzed according to Snedecor and Cochran (1981) and means were compared using LSD at 5% level.

RESULTS AND DISCUSSION

1. Root length and root diameter

Data presented in Table 1 reveal that either spraying beet leaves with K, Mg or B solely or combinations significantly increased root length and root diameter as compared with control, this held true in both seasons. Results in Table 1 detect that the combination between the three elements at higher concentration produced the highest means of root length and root diameter in booth seasons. On the other hand, no significant differences between K and higher concentration combined with Mg and B at both concentrations for root diameter in the first season. The increase in root length and root diameter may be due to the important role of potassium photosynthesis through carbohydrate metabolism, osmotic regulation and improves the autritonal balance and encourages dry matter accumulation as well as translocation of sugar and carbohydrates El-Shafai (1991). Also, the role magnesium for increment photosynthesis operation and consequently the assimilation, translocation and storage capacity, also its role in stimulating cell division and elongation El-Taweel, Fayza (1999). As well as the role of boron in playing a vital role in sugar transportation from green leaves to the storage cells in the root. Similar results were recorded by El-Taweel (1999) and Osman (2005).

2. Root and foliage fresh weights/plant.

Data presented in Table (1) reveal that foliar spray with K and Mg as well as B at both concentrations significantly increased averages of fresh weights of root and foliage/plant at harvest as compared to control. Mg was more effective than either K or B on all studied growth traits.

Regarding with the combinations between the three elements at the two concentrations were significantly increased the means of fresh weights of root and foliage/plant as compared with control, while the higher concentration gave the highest values of this treaties as compared with other treatments. This held true in both seasons. This results could be attributed to that the important of K in physiological processes in plant such as translocation of sugar and carbohydrates. On the other side, the positive effect of Mg may be due to cells division and its role in absorbing phosphorus and activation photosynthesis. Also, the results could be attributed to that B is an essential element for photosynthetic pigmets where it increases rate of photo synthetic U_2 evolution and CO_2 fixation. At the same time it decreases the activates of oxidative pentose phosphate enzymes and respiration Garcia-Gonzalez *et al*. (1990), Rizk *et al*. (1993), El-Taweel, Fayza (1999), Ahmed (2005) and Moustafa, Zeinab *et al.* (2006), revealed the beneficial effect of both K, Mg and B on growth and some quality characteristics of sugar beet plants.

3. Root/top ratio.

Results given in Table 1 indicated that foliar spray with Mg individual significant increased root/top ratio, while spraying K and B Solely decreased root/top ratio, but the differences did not reach to the level of significant as compared with control in both seasons. On the other hand, foliar spray with

the combination between the three elements significantly increased root/top ratio. The highest average resulted from spraying with K combined with Mg and B at higher concentration in the first season and from spraying K and at higher concentration combined with Mg at the two concentration in the second season. Similar results were obtained by El-Taweel, Fayza (1999), Ahmed (2005) and Osman. (2005).

4. Sucrose% and TSS%.

Data in Table 2 showed that the control treatment (with out foliar spray) gave the highest values of Sucrose% and TSS%. On the other hand foliar spraying with K, Mg or B either solely or in combination significantly decreased sucrose and TSS%, this held true in both seasons. Similar results were obtained by Abd El-Gawad *et al*. (2004), Ahmed (2005), Mohamed (2005), Hassanin (2002 and Osman (2005).

5. Purity%.

Results in Table 2 indicated that foliar spray with K, Mg or B solely at both concentrations had no significant effect on purity% in both seasons. On the other hand, the combination between the K and B at low concentrations combined with Mg at both concentrations recorded the highest values for purity% in both seasons.

6. Root, top and sugar yields (ton/fed).

Results recorded in Table (2) show that spraying K, Mg or B solely at both concentration promoted roots, tops and sugar yields as compared to control treatment, the increases were significantly in both seasons. The highest values of root, tops and sugar yields resulted from the combination between the three elements at higher concentration in both seasons, but no significant differences between foliar spray with K at higher concentration combined with Mg and B at both concentration for sugar yield in the second season. The increase in roots, tops and sugar yields were (78.69%, 41.82% and 85%) as well as (73.54%, 51.58% and 48.21%) as compared with control treatment in the first and second seasons, respectively. The superiority of yield by K1 Mg and B might be attribute to their roles in increasing growth traits as mentioned before which finally reflected in better yields. Moreover, B nutrition trends to maintain sugar is easily trans located soluble forms and increasing synthesis of sucrose and subsequently increasing sugar yield. (Omran *et al*., 2002). These results stand in harmony with those recorded by Pardo and Guadlix (1993), El-Moursy *et al*. (1998), Barlog and Grzebize (2001), Ortovius *et al*. (2001), Barlog *et al*. (2002), Nafei (2004), Mohamed (2005), Moustafa *et al*. (2006) and Esmail and Abo El-Hamd (2007).

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تأثير الرش بالبوتاسيوم والماغنسيوم والبورون على المحصول والجودة لبنجر السكر تحت ظروف الاراضى الحديثة.

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أقيمت تجربتان حقليتان فى تصميم القطاعات الكاملة العشوائية فى ثلاث مكررات بقرية الاعتزاز غرب مركز سمالوط محافظة المنيا وذلك فى موسمى٢٠٠٤/٢٠٠٥و ٢٠٠٥/٢٠٠٦بهدف دراسة تأثير الرش بالبوتاسيوم والماغنسيوم والبورون منفردا او معا على المحصول والجودة لبنجر السكر تحت ظروف الاراضى الحديثة حيث اشتملت كل تجربة على خمسة عشر معاملة تمثل التوافق بين مستويين من البوتاسيوم بمعدل ١ و ٢ لتر ٣٦% أكسيد البوتاسيوم ، ومستويين من الماغنسيوم بمعدل ٠,٦ و ١,٢% كبرتيات ماغنسيوم ومستويين من التسميد البورون بمعدل١٠ و ٢٠ ملجم حامض البوريك .

وكانت أهم النتائج مايلى:

أشارت النتائج إلى أن رش نباتات بنجر السكر بالبوتاسيوم أو الماغنسيوم أو البورن أو التفاعلات بينهم أدت إلى زيادة معنوية لطول الجذر وقطر الجذر والوزن الطازج للجذور والأوراق للنبات ومحصول الجذور ومحصول العرش وكذا محصول السكر للفدان. وكانت أعلى القيم لهذه الصفات عن طريق خلط العناصر الثلاثة بأعلى تركيز. أيضا ادى الرش الورقى بالماغنسيوم مفردا أو عن طريق خلطة مع البوتاسيوم أو البورون أدى إلى زيادة فى نسبة وزن الجذور إلى الأوراق فى كلا موسمى الدراسة. وعلى خلاف ذلك أدى عدم الرش إلى الحصول على أعلى القيم فى صفات السكروز والنسبة المئوية للمواد الصلبة الذائبة الكلية بينما أعلى القيم بالنسيبة لصفة النقاوة تم الحصول عليها باستخدام التركيز الأقل من العناصر الثلاثة (البوتاسيوم والماغنسيوم أو البورون) فى كلا موسمى الدراسة.

وتوصى الدراسة للحصول على أعلى محصول من الجذور والسكر لمحصول بنجر السكر الرش بمخلوط العناصر الثلاثة (بوتاسيوم و ماعنسيوم و بورون) بأعلى تركيز.

Table 1: Average of root length, root diameter, root fresh weight/plant (g), foliage fresh weight/plant (g) and root/top ratio as affected by potassium, magnesium and boron fertilization on sugar beet during 2004/2005 and 2005/2006 seasons.

Characters / Treatments	Root length (cm)		Root diameter (cm)		Root fresh weight per plant (gm)		Foliage fresh weight per plant (gm)		Root /top ratio	
	2004/05	2005/06	2004/05	2005/06	2004/05	2005/06	2004/05	2005/06	2004/05	2005/
Control	12.93	14.73	7.16	7.30	506.67	533.33	204.33	208.33	2.48	2.50
Folair spray with K_1	15.60	15.70	7.50	7.67	560.00	590.00	227.33	231.33	2.48	2.50
Folair spray with K_2	17.80	17.97	7.96	8.13	587.33	620.00	247.33	251.00	2.38	2.40
Folair spray with Mg_1	18.53	18.67	8.10	8.27	605.67	676.67	240.00	245.67	2.52	2.70
Folair spray with Mg_2	19.03	19.23	7.63	7.87	654.33	692.33	247.00	252.33	2.65	2.70
Folair spray with B_1	14.36	15.30	7.83	8.03	527.67	554.00	217.33	224.00	2.43	2.40
Folair spray with B_2	15.36	15.67	8.60	8.83	545.00	570.07	227.66	233.00	2.39	2.60
Folair spray with $K_1 Mg_1B_1$	20.90	21.13	8.93	9.13	682.67	707.33	258.33	265.67	2.64	2.60
Folair spray with $K_1 Mg_2B_1$	21.43	21.73	9.10	9.37	706.67	729.67	266.00	273.00	2.65	2.60
Folair spray with $K_1 Mg_1B_2$	21.93	22.30	9.36	9.63	710.66	745.33	265.66	270.00	2.67	2.70
Folair spray with $K_1 Mg_2B_2$	22.56	23.03	9.53	9.87	750.33	765.00	279.66	285.33	2.68	2.60
Folair spray with $K_2 Mg_1B_1$	24.60	24.67	9.83	10.10	776.33	791.17	276.33	287.67	2.81	2.70
Folair spray with $K_2 Mg_2B_1$	25.56	25.80	10.00	10.23	822.33	830.17	282.33	287.33	2.91	2.80
Folair spray with $K_2 Mg_1B_2$	26.16	26.50	10.06	10.30	855.33	880.00	280.33	299.00	3.06	2.90
Folair spray with $K_2 Mg_2B_2$	26.80	27.40	10.26	10.73	905.00	925.67	289.66	315.67	3.18	2.90
F test LSD at $_{0.05\%}$	**0.41**	**0.41**	**0.24**	**0.24**	**15.20**	**10.76**	**4.08**	**4.51**	**0.12**	**0.11**

*** K= 1 liter 36% K_2O K2= 2 liter 36% K_2O Mg1= 5.4 Kg $MgSO_4$**
Mg2=10.8 Kg $MgSO_4$ B1=10 mg L^{-1} boric acid
B2=20 mg L^{-1} boric acid

Table 2: Average of sucrose%, TSS% and Purity%, root yield (ton/fed), top yield (ton/fed) and sugar yield (ton/fed as affected by potassium, magnesium and boron fertilization on sugar beet during 2004/2005 and 2005/2006 seasons.

Characters / Treatments	Sucrose%		TSS%		Purity%		Root yield (ton/fed)		Top yield (ton/fed)		Sugar yiel (ton/fed)	
	2004/05	2005/06	2004/05	2005/06	2004/05	2005/06	2004/05	2005/06	2004/05	2005/06	2004/05	2005
Control	17.83	18.00	21.77	21.67	81.93	83.04	17.73	18.67	7.15	7.29	3.16	3.3
Folair spray with K_1	15.93	15.80	18.87	18.73	84.46	84.39	19.60	20.65	7.95	8.10	3.12	3.2
Folair spray with K_2	16.97	16.47	20.50	19.97	82.77	82.52	20.55	21.70	8.52	8.79	3.50	3.5
Folair spray with Mg_1	16.20	16.47	20.96	20.67	77.32	79.68	21.20	23.68	8.27	8.60	3.43	3.9
Folair spray with Mg_2	17.00	17.17	21.13	21.00	80.44	81.73	22.90	24.23	8.64	8.83	3.89	4.1
Folair spray with B_1	16.10	16.47	20.83	20.63	77.33	79.81	18.47	19.39	7.60	8.17	2.97	3.2
Folair spray with B_2	15.40	15.73	18.73	19.07	82.22	82.54	19.07	19.91	7.97	8.29	2.93	3.1
Folair spray with K_1 Mg_1B_1	16.07	16.23	18.61	18.40	86.40	88.26	23.89	24.76	9.30	9.30	3.84	4.0
Folair spray with K_1 Mg_2B_1	16.10	16.47	18.93	18.87	85.09	87.28	24.73	25.54	9.31	9.56	3.97	4.2
Folair spray with K_1 Mg_1B_2	16.40	16.67	19.67	19.90	83.40	83.77	24.76	26.08	9.30	9.42	4.01	4.3
Folair spray with K_1 Mg_2B_2	15.20	15.53	18.83	18.57	80.70	83.73	26.26	26.78	9.79	9.79	3.99	4.1
Folair spray with K_2 Mg_1B_1	15.53	16.03	18.87	19.00	82.33	84.44	27.17	27.59	9.67	10.67	4.22	4.4
Folair spray with K_2 Mg_2B_1	15.20	15.50	18.47	19.00	82.31	81.57	28.78	28.96	9.88	10.06	4.37	4.9
Folair spray with K_2 Mg_1B_2	15.57	15.93	18.67	18.73	83.44	85.06	30.04	30.08	9.81	10.47	4.68	4.9
Folair spray with K_2 Mg_2B_2	15.23	15.37	19.00	18.93	80.16	81.17	31.67	32.40	10.14	11.05	4.83	4.9
F test LSD at 0.05%	**0.54**	**0.52**	**0.60**	**0.56**	**3.39**	**3.89**	**0.55**	**0.41**	**0.29**	**0.34**	**0.15**	**0.1**

*** K= 1 liter 36% K_2O K2= 2 liter 36% K_2O Mg1= 5.4 Kg $MgSO_4$ Mg2=10.8 Kg $MgSO_4$ B1=10 mg L^{-1} boric acid B2=20 mg L^{-1} boric acid**

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