J. Plant Production, Mansoura Univ., Vol. 7 (9): 963-972, 2016

Response of Sugar Beet to Different Levels of Potassium and Magnesium Fertilization Under Sandy Soil Conditions

Enan, S.A.A.M

Sugar Crops Res. Inst., Agric. Res. Center, Giza, Egypt.

ABSTRACT

Two field experiments were conducted at Wadi El-Natrun, El-Bahira Governorate, (latitude of 30.48^{0} N and longitude of 30.50^{0} E) during 2013/2014 and 2014/2015 seasons to study the effect of potassium and magnesium fertilizers on yield and chemical constituents of sugar beet (*Beta vulgaris var.* saccharifera, L.) grown in a sandy soil. The present work included twelve treatments, which were three potassium levels (50, 75 and 100 kg K_2SO_4/fed) added before canopy closer as potassium sulphate (48% K_2O), in combination with four levels of magnesium: (without magnesium, 20, 50 and 80 kg $MgSO_4$/fed in the form of magnesium sulphate ($MgSO_4$. 7 H_2O) containing 10% MgO, which was added after seed bed preparation and after plotting. The treatments were arranged in a strip plots design in three replicates. The vertical plots were occupied with the three levels of potassium and the horizontal plots were devoted to the four levels of magnesium. The results showed that fertilizing sugar beet with 75 kg and/or 100 kg K_2SO_4/fed produced significantly higher values of chlorophyll (b) and carotenoids, root fresh weight/plant, sucrose% and foliage contents of K and Mg, in both seasons. Applying of 75 kg K_2SO_4/fed significantly decreased the amount of Na, K, alph amino-N contents in roots, sugar lost to molasses% and increased quality index as well as extractable sugar, in both seasons. Meantime, chlorophyll (a), nitrogen and phosphorus contents in leaves, magnesium uptake in roots, root diameter and foliage fresh weight/plant, root/top ratio were insignificantly affected by potassium levels studied. Increasing magnesium fertilizer up to 80 kg $MgSO_4$/fed resulted in higher values of photosynthetic pigments, root and top fresh weights/plant, root/top ratio, foliage contents of N, K, P and Mg as well as magnesium uptake in roots. Moreover, it improved sucrose, extractable sugar and quality index percentages significantly, in both seasons. Meantime, potassium and sodium contents in beet roots were insignificantly influenced by the applied magnesium levels. The interaction between potassium and magnesium levels had a significant effects on leaf content of chlorophyll (a), root diameter, nitrogen content in leaves and root yield/fed, in both seasons as well as sugar yield/fed, in 1st one. The combination of 75 kg K_2SO_4/fed + 80 kg $MgSO_4$/fed achieved the maximum root yield (27.88 and 27.07 t/fed) in the 1st and 2nd season, respectively and the highest sugar yields (4.51 t/fed) in 1st one . It could be concluded that the application of K_2SO_4 at the rate of 75 kg and $MgSO_4$ at the rate of 80 kg is the suitable recommendation to maximize the productivity and quality of sugar beet grown in a sandy soils at Wady El-Natrun.

Keywords: Magnesium, Potassium, Sandy soil, Sugar beet.

INTRODUCTION

The optimum root beet and sucrose production relies on a balanced fertilization program of N, P and K, in addition to some other essential elements such as magnesium, to ensure rapid plant growth for early canopy closure and optimum photosynthesis efficiency for sucrose accumulation in roots. Potassium helps to regulate the amount of carbon dioxide that enters leaves for use in photosynthesis (sugar formation) and magnesium plays an important role as the central atom of the chlorophyll molecule in the light-absorbing complex of chloroplasts and its contribution to photo-synthetic fixation of carbon dioxide (Cakmak and Kirkby, 2008). Both potassium and magnesium are essential for optimum nitrogen use efficiency by sugar beets as they have critical functions in photosynthesis, phloem loading of sucrose, and biomass distribution among the plant parts. They perform critical roles in the production of a high yield of roots and a high sucrose% in those roots (Hermans *et al*., 2006). Amer *et al*. (2004) found that adding potassium up to 90 kg K_2O/fed resulted in a significant increase in N %, P % and K % in root, root and sugar yields/fed, sucrose and purity percentages. Osman (2005) reported that Mg fertilizer caused a significant effect on (root length and diameter), root fresh weight/plant, sucrose, purity percentages and (root, top and sugar yields/fed) of sugar beet crop. So, absence of these mineral nutrients in a balanced fertilization program will result in significant adverse effects on growth and development of plants. Moustafa *et al*. (2006) obtained that the high root and sugar yields/fed, sucrose%, quality index and impurities contents (α amino-N, Na and K) increase by increasing potassium level up to 48 kg K_2O/fed. Celik *et al*. (2010) obtained that the highest K^+ concentration in beet at the highest level of K fertilization, which may have some molassegenic effect to extract sugar from sugar beet pulp. They added that the increase in beet yield and quality can be correlated to potassium in leaves and roots, as the K^+ is increased by increasing potassium fertilization. Enan (2011) cleared that the application of 24 kg k_2O/fed + two sprays of potassien significantly resulted in the highest values of root and top fresh weights, root and sugar yields/fed as well as quality and sucrose percentages. Mehran and Samad (2013) mentioned that increasing K rates significantly increased root and foliage fresh weight as well as sugar yield/fed.

Magnesium is involved in many physiological and biochemical processes. It plays a key role in plant defense mechanisms in a biotic stress situation. So, it is expected that Mg deficiency would have damaging effects on photosynthesis and respiration especially associated with strongly leached in sandy soils with a low cation exchange capacity. Both Mg deficiency and oversupply have detrimental effects on plant photosynthesis, consequently resulting in abnormal or restricted growth of plants (Shaul, 2002). Magnesium deficiency causes chlorosis, yellowing, scorching of the inter-venial tissues of the leaf blade of sugar beet plants, and eventually, necrosis, and hence leads to a decreasing rate of root growth, preceding any response of aboveground parts and then come back later a reduction in leaf growth as the primary response (Hermans *et al*., 2005). El-Sayed (2005) clarified that soil application of zero, 4 and 8 kg MgO/fed attained a significant differences in root yield/fed and root fresh weight/plant, sucrose%, quality index% and sugar yield/fed. Malnou *et al*. (2006) mentioned that the response of sugar beet to Mg, applied to the soil or plant foliage in early stages of growth, is reflected in higher yield of storage roots in treatments receiving a relatively low N rate. Abou El-Magd *et al*. (2013) noticed that foliar application with magnesium had an obvious effect on photosynthetic pigments; maximized yield and quality of sugar beet plants. The highest values of these traits were obtained by application of 5 kg MgO/fed in both seasons. On the other hand, unfertilized plants produced the lowest ones.

The present investigation seeks the appropriate syntheses of K and Mg to maximize yield and quality of sugar beet under sprinkler system in sandy soil.

MATERIALS AND METHODS

Two field experiments were conducted at Wadi El-Natrun, El-Bahira Governorate, (latitude of 30.48^0 N and longitude of 30.50^0 E) during 2013/2014 and 2014/2015 seasons to study the effect of potassium and magnesium fertilizers on yield and chemical constituents of sugar beet (*Beta vulgaris var.* saccharifera, L.) grown in a sandy soil. The present work included twelve treatments, which were three potassium levels (50, 75 and 100 kg K_2SO_4/fed) added before canopy closer as potassium sulphate (48% K_2O), in combination with four levels of magnesium: (without magnesium, 20, 50 and 80 kg $MgSO_4$/fed in the form of magnesium sulphate ($MgSO_4$. 7 H_2O) containing 10% MgO, which was added after seed bed preparation and after plotting. The treatments were arranged in a strip plots design in three replicates. The vertical plots were occupied with the three levels of potassium and the horizontal plots were devoted to the four levels of magnesium. The plot area was 21.60 m^2 including 12 rows of 4-m in length and 45-cm between rows, with 17-cm hill spacing filled with one seed/hill. Phosphorus fertilizer was applied in the form of calcium super phosphate (15 % P_2O_5) at the rate of 200 kg/fed at seed bed preparation. Nitrogen fertilizer was applied as ammonium nitrate at the rate of 100 kg N/fed, which was split as follows: 10 kg N/fed at age of 20 days after sowing, followed by 10 kg N/fed, two doses of 25 kg N/fed were added twice as a soil application after hoeing, 20 kg N/fed at age of 80 days after sowing and 10 kg N/fed at 100 days from sowing. Seeds of the mono-germ sugar beet variety "Elmo" were sown mechanically under sprinkler irrigation system during the 2^{nd} week of September in both seasons. Harvesting was done at age of 7 months in both seasons.

Some physical properties of soil were analyzed using the procedure described by Black *et al*. (1981). Soil chemical analysis was determined according to the method described by Jackson (1973). Physical and chemical analyses of the soil (the upper 60-cm) of the experimental site are given in Table 1.

Table 1: **Physical and chemical properties of a representative soil sample of the experimental site in 2013-2014 and 2014-2015 seasons**.

Soil properties	**2013/2014 season**	**2014/2015 season**
Particle size distribution:		
sand %	90.54	89.24
Silt %	3.00	4.62
Clay %	6.46	6.14
Texture class	Sandy	Sandy
Organic Matter %	0.43	0.47
Available Nitrogen mg/kg soil	48	51
Available P_2O_5 mg/kg soil	14.2	15.1
Available K_2O mg/kg soil	125.6	133.5
Available Mg^{+2} mg/kg soil	10.50	13.0
Available Ca^{+2} mg/kg soil	168	245
pH at (1:2.5) soil:water suspension	8.40	8.35
EC dS/m^{-1}	0.58	0.63
Soluble Cations (meq/L^{-1})		
K^+	1.45	1.60
Na^+	0.81	0.88
Mg^{++}	1.02	1.14
Ca^{++}	2.22	2.45
Soluble Anions (meq/L^{-1})		
$So_4^=$	2.45	2.85
Cl^-	2.41	2.50
HCO_3^-	0.64	0.72
$CO_3^=$	-	-

The recorded data:

After 105 days from sowing, random samples of five sugar beet plants were taken from each plot to determine the following traits:

1. Photosynthetic pigments, *i.e.* chlorophyll a, b and carotenoides (mg/g leaf fresh weight), as according to the method of Wettstein (1957).

At harvest time, the following traits were estimated:

*** Yield components**:

1. Root diameter (cm).
2. Root and foliage fresh weights (g/plant).
3. Root/top ratio.

*** Chemical and quality characteristics**:

4. Sucrose percentage (Pol%) was estimated in fresh samples of sugar beet roots, using Saccharometer according to the method described in **A.O.A.C. (2005)**.
5. Sugar lost to molasses percentage (SLM %) was calculated by the following formula, according to

Devillers (1988):

SLM% = 0.29 + (Na + K) 0.343 + 0.094 (α-amino N).

6. Juice quality percentage (QZ %) was calculated according to **Cooke and Scott**, **(1993)** using the following equation:

Q Z % = (extractable sugar % x100)/Pol %.

7. Impurities%: K, Na and α-amino N contents were estimated as meq/100 g beet according to the procedure of sugar company using an Automated Analyzer as described in **Cooke** and **Scott (1993)**.

8. Extractable sugar % was calculated using the following equation according to Cooke and Scott (1993):

Extractable sugar % = (Pol % - 0.29) - 0.343 (K + Na) - α- amino N (0.0939).

Where: K, Na and α-amino N were determined as meq/100 g beet.

9. Foliage contents of N, P, K and Mg:

The dry matter of leaves was digested using an acid mixture consisting of nitric, perchloric and sulfuric acids in the ratio of 8:1:1 (v/v), respectively (Chapman and Pratt, 1978). Nitrogen (N) was determined using boric acid modification described by Ma and Zuazage (1942), and distillation was done using Gerhardt apparatus. Phosphorus was spectro-photometrically determined using the molybdate-vanadate method according to Jackson (1973). Potassium was measured using Dr. Lang-M8D Flame-photometer. Magnesium was determined using the Atomic Absorption Spectrophotometer (Perkin-Elmer 100 B).

*** Root and sugar yields (t/fed)**:

Plants of six guarded ridges were uprooted and weighed to determine the following parameters:

10. Root yield (t/fed).

11. Sugar yield = root yield (ton) x extracted sugar %.

All data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the strip plot design as published by Gomez and Gomez (1984) by means of "MSTAT-c" computer software package. Least significant differences between treatment means at 5% level of probability as were described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

1. Photosynthetic pigments:

Data in Table 2 showed that a significant effect of potassium levels on photosynthetic pigments, *i.e.* chlorophyll (b) and carotenoids, in both seasons. Meanwhile, insignificant differences in chlorophyll (a) were found among the studied treatments. Fertilizing beet plants with 100 kg/K_2SO_4 resulted in higher values of chlorophyll (b) and carotenoids, without significant difference with those supplied with 70 kg/K_2SO_4. The positive influence of raising K-level may be attributed to the increase in the chloroplast number/cell, cell expansion, chloroplast multiplication and the amount of chlorophyll/disc. Such results came along with those reported by Bohra *et al*. (2006).

Concerning the effect of magnesium levels, data in the same Table clear that increasing the rate of Mg increased the chlorophylls (a and b) and carotenoids contents. Fertilizing sugar beet with 80 kg $MgSO_4$/fed led to a positive effect on photosynthetic pigments, in both seasons. These results may be due to the role of magnesium element, owing biological functions in plants, where Mg is essential in photosynthesis process for harvesting solar energy and to drive photochemistry (Pakrasi *et al*., 2001). Also, Mg has an important role in promoting the synthesis of chlorophyll and photosynthetic pigments (Abou El-Magd *et al*., 2013).

The interaction between potassium and magnesium fertilization levels had a significant effect on chlorophyll (a) in both seasons (Table 2).

Table 2: **Photosynthetic pigments (mg/g fresh weight) as affected by potassium and magnesium fertilization levels in 2013/2014 and 2014/2015 seasons**.

Characters	Photosynthetic pigments (mg/g fresh weight)					
	Chlorophyll (a)		Chlorophyll (b)		Carotenoids	
Treatments	1st season	2nd season	1st season	2nd season	1st season	2nd season
K_2SO_4 levels (kg/fed)						
50	1.77	1.84	0.65	0.83	0.37	0.40
75	2.56	2.34	1.22	1.19	0.80	0.55
100	2.48	2.26	1.25	1.30	0.76	0.63
LSD at 0.05 level	**NS**	**NS**	**0.50**	**0.34**	**0.34**	**0.15**
$MgSO_4$ levels (kg/fed)						
Without Mg	1.91	1.83	0.85	0.77	0.50	0.37
20	2.25	2.07	0.98	1.10	0.57	0.47
50	2.34	2.23	1.09	1.22	0.74	0.61
80	2.57	2.46	1.22	1.34	0.77	0.66
LSD at 0.05 level	**0.14**	**0.20**	**0.10**	**0.19**	**0.13**	**0.10**
K x Mg	**	**	NS	NS	NS	NS

*** 50 kg K_2SO_4 (48% K_2O) equivalent to 24 kg K_2O**
*** 75 kg K_2SO_4 (48% K_2O) equivalent to 36 kg K_2O**
*** 100 kg K_2SO_4 (48% K_2O) equivalent to 48 kg K_2O**
*** 20 kg $MgSO_4$ (10% MgO) equivalent to 2 kg MgO**
*** 50 kg $MgSO_4$ (10% MgO) equivalent to 5 kg MgO**
*** 80 kg $MgSO_4$ (10% MgO) equivalent to 8 kg MgO**

Interaction effect:

Data in Table 3 cleared that the difference in chlorophyll (a) in leaves of beet plants fertilized with 20 kg $MgSO_4$ /fed and those untreated was insignificant, when plants were fertilized with 50 kg K_2SO_4/fed, in both seasons. However, the variance in this trait between those two levels of magnesium was significant under the other potassium treatments. The highest values of chlorophyll (a) were recorded when plants treated by 75 kg K_2SO_4/fed with 80 kg $MgSO_4$ /fed, in both seasons. The obatined results were close to those reported by (Hermans *et al*., 2005) and (Camak and Kirkby, 2008) who suggested that Mg involved in protein synthesis and 15-20 of total Mg associated with chlorophyll pigments, acting mainly as a cofactor of a series of enzumes involved in photosynthetic carbon fixation and metabolism.

Table 3: **Chlorophyll (a) as affected by the interaction between potassium and magnesium fertilization levels in 2013/2014 and 2014/2015 seasons**.

Treatments	2013/ 2014 season Without Mg (control)	 20 kg $MgSO_4$	 50 kg $MgSO_4$	 80 kg $MgSO_4$	2014/ 2015 season Without Mg (control)	 20 kg $MgSO_4$	 50 kg $MgSO_4$	 80 kg $MgSO_4$
50 kg K_2SO_4	1.58	1.53	1.73	2.22	1.65	1.79	1.85	2.07
75 kg K_2SO_4	1.99	2.70	2.76	2.81	1.87	2.23	2.53	2.73
100 kg K_2SO_4	2.17	2.52	2.53	2.69	1.98	2.18	2.30	2.57
LSD at 0.05% level for :				**0.31**				**0.19**

*** 50 kg K_2SO_4 (48% K_2O) equivalent to 24 kg K_2O** *** 20 kg $MgSO_4$ (10% MgO) equivalent to 2 kg MgO**
*** 75 kg K_2SO_4 (48% K_2O) equivalent to 36 kg K_2O** *** 50 kg $MgSO_4$ (10% MgO) equivalent to 5 kg MgO**
*** 100 kg K_2SO_4 (48% K_2O) equivalent to 48 kg K_2O** *** 80 kg $MgSO_4$ (10% MgO) equivalent to 8 kg MgO**

2. **Root diameter**, **root/top ratio**, **root and foliage fresh weights/plant**:

The results in Table 4 revealed that root fresh weight of sugar beet was significantly affected by the used K fertilization levels, in both seasons, On the contrary, root diameter, foliage fresh weight and root/top ratio insignificantly responded to K levels, in both seasons. Heavier roots were produced by supplying sugar beet plants with 75 and/or 100 kg K_2SO_4/fed (without significant variance between these two levels), as compared with those given 50 kg K_2SO_4. The appreciable influence of K could be referred to its role in accelerating photosynthetic activity, translocation of sucrose from leaves to be accumulated in roots. Also, it could be due to its role of K on carbohydrate and N-metabolism, water absorption and transpiration in plant. These results are in harmony with those obtained by Enan (2011).

Table 4: **Root diameter (cm)**, **root**, **foliage fresh weights/plant and root/top ratio as affected by potassium and magnesium fertilization levels in 2013/2014 and 2014/2015 seasons**.

Characters / Treatments	Root fresh weight (g/plant) 1st season	 2nd season	Foliage fresh weight (g/plant) 1st season	 2nd season	Root/top ratio 1st season	 2nd season	Root diameter (cm) 1st season	 2nd season
K_2SO_4 levels (kg/fed)								
50	543.4	546.7	262.2	267.9	2.08	2.04	8.81	8.29
100	683.6	628.7	268.3	271.3	2.58	2.32	9.31	8.84
150	677.7	605.0	290.1	263.3	2.34	2.30	9.23	8.76
LSD at 0.05 level	**81.0**	**46.0**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
$MgSO_4$ levels (kg/fed)								
Without Mg	514.6	512.7	249.3	258.8	2.07	1.99	8.83	8.00
20	598.0	572.2	262.9	263.9	2.28	2.17	9.07	8.70
50	690.2	625.6	279.3	268.3	2.50	2.33	9.16	8.77
80	736.9	663.3	302.6	278.9	2.47	2.38	9.39	9.05
LSD at 0.05 level	**61.0**	**50.0**	**19.0**	**9.5**	**0.17**	**0.16**	**NS**	**NS**
K x Mg	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**	**

*** 50 kg K_2SO_4 (48% K_2O) equivalent to 24 kg K_2O** *** 20 kg $MgSO_4$ (10% MgO) equivalent to 2 kg MgO**
*** 75 kg K_2SO_4 (48% K_2O) equivalent to 36 kg K_2O** *** 50 kg $MgSO_4$ (10% MgO) equivalent to 5 kg MgO**
*** 100 kg K_2SO_4 (48% K_2O) equivalent to 48 kg K_2O** *** 80 kg $MgSO_4$ (10% MgO) equivalent to 8 kg MgO**

Results in the same Table cleared that root, foliage fresh weights and root/top ratio increased significantly by increasing Mg level, in both seasons. It was found that fertilizing sugar beet with 50 and/or 80 kg $MgSO_4$/fed attained heavier foliages, roots and higher rate of transition from the leaves to the roots as compared with the check treatment and those received 20 kg $MgSO_4$/fed. Beneficial influence of raising the applied Mg level given to sugar beets may be due to increasing the efficiency of the transmission of nutrients from leaves to roots, where it acts as activator or regulator of many key enzymes in plant physiological processes furthermore, it is crucial in the citric acid cycle, which is required for cell respiration, where the synthesis of proteins, fats and carbohydrates be optimized (El-Sayed, 2005).

The difference between 50 and 80 kg $MgSO_4$/fed was insignificant in their effect on root fresh weight and root/top ratio, whilst the difference between these two rates was significant in their effect on foliage fresh weight/plant. On the other hand, increasing $MgSO_4$ levels from zero up to 80 kg/fed failed to reach the level of significance in their effect on root diameter in both seasons.

The interaction between potassium and magnesium fertilization levels had a significant effect on root diameter in both seasons (Table 4).

Interaction effect:

Data in Table 5 clear that root diameter was significantly affected by the interaction between potassium and magnesium levels in both seasons. Root diameter responded to the increase of applied magnesium level, but was higher magnitude in the fertilized with 75 kg K_2SO_4/fed than the rest of potassium levels. This effect was clearer when increase the magnesium level to 80 kg $MgSO_4$/fed. Therefore, the highest mean value of root diameter was recorded by fertilizing beet plants with 75 kg K_2SO_4, with 80 kg $MgSO_4$/fed. These results clearly indicate an integrative effect between intermediate dose of potassium and high dose of magnesium to produce the thickest roots, which is reflected on root yield/fed and resulted in increasing width of cambia rings and its abilities to store more sucrose of roots.

Table 5: **Root diameter as affected by the interaction between potassium and magnesium fertilization levels in 2013/2014 and 2014/2015 seasons**.

Treatments	2013/ 2014 season				2014/ 2015 season			
	Without Mg (control)	20 kg $MgSO_4$	50 kg $MgSO_4$	80 kg $MgSO_4$	Without Mg (control)	20 kg $MgSO_4$	50 kg $MgSO_4$	80 kg $MgSO_4$
50 kg K_2SO_4	8.65	8.79	8.78	9.00	8.20	8.26	8.29	8.41
75 kg K_2SO_4	8.87	9.23	9.47	9.67	8.48	8.64	8.78	9.46
100 kg K_2SO_4	8.98	9.18	9.23	9.51	7.32	9.19	9.23	9.29
LSD at 0.05% level for :				**0.19**				**0.64**

*** 50 kg K_2SO_4 (48% K_2O) equivalent to 24 kg K_2O** *** 20 kg $MgSO_4$ (10% MgO) equivalent to 2 kg MgO**
*** 75 kg K_2SO_4 (48% K_2O) equivalent to 36 kg K_2O** *** 50 kg $MgSO_4$ (10% MgO) equivalent to 5 kg MgO**
*** 100 kg K_2SO_4 (48% K_2O) equivalent to 48 kg K_2O** *** 80 kg $MgSO_4$ (10% MgO) equivalent to 8 kg MgO**

3. **Nitrogen**, **phosphorus**, **potassium and magnesium contents in leaves**:

The results in Table 6 pointed out that a significant effect of K fertilization levels on both potassium and magnesium contents in leaves, while N and P contents in leaves were insignificantly influenced by K levels in both seasons. Application of 100 kg K_2SO_4/fed led to significantly increased potassium content of the beet plants. These result may be due to amount of K_2SO_4 in the soil is under the critical limits. So, applying sugar beet plants with K^+ has a significant increase uptake it in leaves, hence a large concentration of potassium ensures uptake of balanced amount of nutrients that increases synthesis of carbohydrates also, it has always very critical role in translocation of assimilates to sink (Celik *et al*., 2010). On the contrary, applying 75 kg K_2SO_4/fed led to significant increase in magnesium contents in leaves/plant over those which received 100 or 50 kg K_2SO_4/fed. This finding may be due to there are interactions between Mg^{+2} and other ions such as K^+ where, high rate of potassium competing with Mg for apoplast binding sites (antagonism), hence possibly competes for transporters (Marschner, 2012).

Table 6: **Nitrogen**, **phosphorus**, **potassium and magnesium contents in leaves (mg/100 g plant) as affected by potassium and magnesium fertilization levels in 2013/2014 and 2014/2015 seasons**.

Characters	Nitrogen content in leaves (mg/100 g plant)		Phosphorus content in leaves (mg/100 g plant)		Potassium content in leaves (mg/100 g plant)		Magnesium content in leaves (mg/100 g plant)	
Treatments	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
K_2SO_4 levels (kg/fed)								
50	296.3	289.3	50.53	47.08	158.8	163.7	318.8	286.4
75	356.7	303.8	49.57	47.42	190.1	200.8	494.6	402.3
100	344.7	306.3	47.83	46.22	211.6	229.4	434.1	346.7
LSD at 0.05 level	**NS**	**NS**	**NS**	**NS**	**19.66**	**26.32**	**58.3**	**53.2**
$MgSO_4$ levels (kg/fed)								
Without Mg	304.3	284.3	45.11	44.70	191.3	206.0	349.6	306.0
20	322.4	298.1	48.82	46.41	193.8	201.6	383.6	340.4
50	345.0	303.4	49.67	47.21	184.0	195.0	446.7	355.6
80	358.6	313.3	53.65	49.29	176.6	189.3	483.4	378.4
LSD at 0.05 level	**10.80**	**9.50**	**3.65**	**1.99**	**12.90**	**11.50**	**61.8**	**29.60**
K x Mg	**	**	NS	NS	NS	NS	NS	NS

*** 50 kg K_2SO_4 (48% K_2O) equivalent to 24 kg K_2O** *** 20 kg $MgSO_4$ (10% MgO) equivalent to 2 kg MgO**
*** 75 kg K_2SO_4 (48% K_2O) equivalent to 36 kg K_2O** *** 50 kg $MgSO_4$ (10% MgO) equivalent to 5 kg MgO**
*** 100 kg K_2SO_4 (48% K_2O) equivalent to 48 kg K_2O** *** 80 kg $MgSO_4$ (10% MgO) equivalent to 8 kg MgO**

Raising Mg levels from zero up to 80 kg $MgSO_4$/fed resulted in a significant increase in phosphours content in leaves and magnesium uptake in roots as compared to other Mg treatments. On the other hand, fertilizing beet with 50 and/or 80 kg $MgSO_4$/fed achieved an increase in potassium and magnesium contents in leaves without significant differences between them. This result may be due to that increased Mg translocation from the root to the leaves may be an adaptive response of beet plants to the Mg stress (Table 1). Thus it can be explained the root growth significantly increased indicating that a considerable proportion of dry matter was partitioned to the roots, leading to an increase in root/top ratio, increasing root and sugar yields/fed. The obtained increases with Mg application could be due to its role on harvest solar energy and to drive photochemistry and N-metabolism, also, it teams with phosphorus to help provide energy for rapid early-season plant growth. Virtually all of the energy storage phosphate ATP and ADP molecules in cells exist in complexes with Mg ions. These results are in harmony with those obtained by Cakmak and Kirkby (2008) they emphasized the importance role of Mg in assimilate translocation major nutrients from source to sink organs, which increases root growth, root and top dry weight/plant, as well as may enhance crop–microbe competition for N uptake.

The interaction between potassium and magnesium fertilization levels had insignificant effect on the above-mentioned traits, with the exception of nitrogen contents in leaves in both seasons (Table 6).

Table 7:**Nitrogen content in leaves as affected by the interaction between potassium and magnesium fertilization levels in 2013/2014 and 2014/2015 seasons**.

Treatments	2013/ 2014 season				2014/ 2015 season			
	Without Mg (control)	20 kg $MgSO_4$	50 kg $MgSO_4$	80 kg $MgSO_4$	Without Mg (control)	20 kg $MgSO_4$	50 kg $MgSO_4$	80 kg $MgSO_4$
50 kg K$_2$SO4	270.0	278.3	311,7	325.0	276.0	286.3	294.0	300.7
75 kg K$_2$SO4	339.7	348.0	361.7	377.7	294.0	298.0	300.7	322.7
100 kg K_2SO_4	303.2	341.0	361.7	373.0	283.0	310.0	315.7	316.7
LSD at 0.05% level for :				**15.73**				**7.50**

*** 50 kg K_2SO_4 (48% K_2O) equivalent to 24 kg K_2O**
*** 75 kg K_2SO_4 (48% K_2O) equivalent to 36 kg K_2O**
*** 100 kg K_2SO_4 (48% K_2O) equivalent to 48 kg K_2O**
*** 20 kg $MgSO_4$ (10% MgO) equivalent to 2 kg MgO**
*** 50 kg $MgSO_4$ (10% MgO) equivalent to 5 kg MgO**
*** 80 kg $MgSO_4$ (10% MgO) equivalent to 8 kg MgO**

Data in Table 7 show that nitrogen content in leaves of beets plants was significantly affected by the interaction between potassium and magnesium levels in both seasons. Adding 75 kg K_2SO_4/fed a long with 80 kg $MgSO_4$/fed recorded the highest values of nitrogen content in leaves in both seasons. These result may be due to Mg also serves as a regulator of cation–anion balance in cells and as an osmotically active ion regulating cell turgor together with potassium, as well as Mg owing its ameliorating function in arable soils meets the main requirement sustainable nitrogen where, it is considered as a crucial nutrient for the uptake nitrogen, the main reason is that hydrogen pump efficiency requires high H^+-ATP-ase activity, depending in turn on Mg as an enzyme cofactor (Hermans *et al*., 2006).

4. Magnesium uptake in roots, **sucrose%**, **potassium and sodium contents**:

Data in Table 8 denote that magnesium uptake in roots in both seasons was insignificantly influenced by applied potassium levels. The fertilization with 75 and/or 100 kg K_2SO_4/fed was recorded higher values of sucrose% without significant difference between them. These result assured the important role of potassium element in photosynthetic activity, translocation of sucrose from leaves and its accumulation in roots. These findings are in agreement with those concluded by Enan (2011). Raising potassium level up to 100 kg K_2SO_4/fed resulted in a gradual increase in potassium and sodium contents in root, as compared with the application of 75 kg K_2SO_4/fed, in both seasons. These results may be due to that Na content in the roots is the primary cause of the differences in water concentration and can cause major changes in the recoverable sugar concentration in the fresh root. Potassium, sodium and alpha amino-N contents are impurities and their ratio interferes with the crystallization process, which cause a greater proportion of the sugars to be recovered as molasses with a reduction in refined sugar (Carter, 1986).

Table 8: **Magnesium uptake in roots (mg/100 g plant)**, **sucrose%**, **potassium and sodium contents (meq/100 g beet) as affected by potassium and magnesium fertilization levels in 2013/2014 and 2014/2015 seasons**.

Characters / Treatments	Mg uptake in roots (mg/100 g plant)		Sucrose percentage		Potassium (meq/100 g beet)		Sodium (meq/100 g beet)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
K_2SO_4 levels (kg/fed)								
50	4.37	2.77	15.23	15.45	3.21	3.25	1.58	1.38
75	5.16	3.45	15.94	16.20	3.34	3.34	1.21	1.15
100	4.64	3.50	16.16	16.43	3.79	3.55	1.45	1.41
LSD at 0.05 level	**NS**	**NS**	**0.40**	**0.31**	**0.43**	**0.18**	**0.19**	**0.20**
$MgSO_4$ levels (kg/fed)								
Without Mg	3.64	2.80	15.11	15.47	3.44	3.46	1.49	1.41
20	4.29	3.09	15.64	16.03	3.56	3.45	1.43	1.32
50	5.18	3.40	15.88	16.09	3.45	3.36	1.33	1.31
80	5.78	3.67	16.48	16.52	3.34	3.26	1.39	1.23
LSD at 0.05 level	**0.50**	**0.23**	**0.49**	**0.42**	**NS**	**NS**	**NS**	**NS**
K x Mg	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

*** 50 kg K_2SO_4 (48% K_2O) equivalent to 24 kg K_2O**
*** 75 kg K_2SO_4 (48% K_2O) equivalent to 36 kg K_2O**
*** 100 kg K_2SO_4 (48% K_2O) equivalent to 48 kg K_2O**
*** 20 kg $MgSO_4$ (10% MgO) equivalent to 2 kg MgO**
*** 50 kg $MgSO_4$ (10% MgO) equivalent to 5 kg MgO**
*** 80 kg $MgSO_4$ (10% MgO) equivalent to 8 kg MgO**

Concerning the effect of magnesium levels, the data in the same Table clear that potassium and sodium contents in beet roots were insignificantly influenced by the applied magnesium levels in both seasons. Meantime, sucrose % was significantly affected by fertilizing plants with Mg levels. Applying beets with 80 kg $MgSO_4$ recorded a significant increase in values of sucrose amounted to 0.60 and 0.43 in the 1^{st} and 2^{nd} season, respectively over those fertilized with 50 kg $MgSO_4$. This result may be due to the fact that the untreated beet plants with Mg disrupt the loading of sucrose into phloem, resulting in carbon accumulation in leaves. Re-supply of Mg rapidly enhanced sucrose export to phloem from leaves (Marschner, 2012). Such rapid recovery of sucrose export was found under supply with 80 kg/fed; indicating that enhancement of sucrose export after Mg re-supply is associated not only with photosynthesis but also with Mg availability. A decline in Magnesium-ATP concentration at the phloem-loading sites may be the major reason for inhibition of sucrose transport from Mg-deficient source leaves (Amer *et al*., 2004).

Theinteraction between potassium and magnesium fertilization failed to reach the level of significance in their effect on the above-mentioned traits in both seasons (Table 8).

5. **Alpha amino-N**, **sugar lost to molasses**, **extractable sugar and quality index percentages**:

Data in Table 9 clarified that significant effect of potassium levels on alpha amino-N, sugar lost to percentages. Fertilizing sugar beet with 75 kg molasses, extractable sugar and quality index K_2SO_4/fed led to significance lower values of alpha amino-N, comparison with those fertilized with 50 and 100 kg K_2SO_4/fed in both seasons. Whilst, fertilizing beet plants with 50 and/or 75 reduced significantly the values of sugar lost to molasses% comparison with those fertilized with 100 kg K_2SO_4/fed in both seasons. Similarly, quality index% was significantly achieved an increase amounted to 1.41 and 0.80 in the 1^{st} and 2^{nd} season, respectively by applying 75 kg K_2SO_4/fed over those fertilized with 100 kg K_2SO_4/fed. The highest values of extractable sugar% were recorded in plants treated with 75 kg and/or 100 kg K_2SO_4/fed, in both seasons. These findings coincided with those obtained by Moustafa *et al*. (2006).

In the same Table it was noticed that increasing magnesium level from 20 kg up to 80 kg $MgSO_4$/fed failed to reach the level of significance in their effect on sugar lost to molasses% in both seasons. Application of 80 kg $MgSO_4$/fed resulted in the highest value of extractable sugar% compared to the other Mg treatments. Feeding sugar beet plants with 50 and/or 80 kg $MgSO_4$/fed without significance difference between them gave the highest values of quality index%. These results may be due to higher values of sucrose % and lower values of sodium (Table 8) and alpha amino-N contents in root. These results assured the magnesium's role and its impact on quality attributes in fertilizing sugar beet **(El-Sayed**, **2005)**.

The interaction between potassium and magnesium fertilization failed to reach the level of significance in their effect on the previously mentioned traits in both seasons (Table 9).

Table 9: **Alpha amino-N (meq/100 g beet)**, **sugar lost to molasses**, **extractable sugar and quality index percentages as affected by potassium and magnesium fertilization levels in 2013/2014 and 2014/2015 seasons**.

Characters / Treatments	Alpha amino – N (meq/100 g beet) 1st season	2nd season	Sugar lost to molasses% 1st season	2nd season	Extractable sugar % 1st season	2nd season	Quality index% 1st season	2nd season
K_2SO_4 levels (kg/fed)								
50	1.39	1.27	2.05	1.99	13.18	13.46	86.46	87.15
75	1.23	1.17	1.96	1.93	13.98	14.27	87.72	87.92
100	1.43	1.34	2.21	2.11	13.95	14.32	86.31	87.12
LSD at 0.05 level	**0.16**	**0.04**	**0.18**	**0.12**	**0.35**	**0.33**	**1.08**	**0.69**
$MgSO_4$ levels (kg/fed)								
Without Mg	1.46	1.24	2.11	2.07	13.00	13.41	86.02	86.56
20	1.42	1.26	2.13	2.03	13.52	13.99	86.39	87.29
50	1.30	1.28	2.04	2.00	13.84	14.09	87.13	87.51
80	1.20	1.25	2.02	1.93	14.46	14.58	87.77	88.23
LSD at 0.05 level	**0.15**	**NS**	**NS**	**NS**	**0.41**	**0.39**	**0.72**	**0.81**
K x Mg	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

*** 50 kg K_2SO_4 (48% K_2O) equivalent to 24 kg K_2O**
*** 75 kg K_2SO_4 (48% K_2O) equivalent to 36 kg K_2O**
*** 100 kg K_2SO_4 (48% K_2O) equivalent to 48 kg K_2O**
*** 20 kg $MgSO_4$ (10% MgO) equivalent to 2 kg MgO**
*** 50 kg $MgSO_4$ (10% MgO) equivalent to 5 kg MgO**
*** 80 kg $MgSO_4$ (10% MgO) equivalent to 8 kg MgO**

6. **Root and sugar yields/fed**:

Results in Table 10 reveals that neither the lowest nor the highest level of K_2SO_4/fed attained a significant effect on the values of root, sugar yields/fed. Application of 75 and/or 100 kg K_2SO_4/fed resulted in higher values of sugar yield/fed in 2^{nd} season compared to 50 kg K_2SO_4. The increase in sugar yield/fed may be due to the important role of potassium in photosynthesis, carbohydrate metabolism, protein synthesis. This result is in emphasized with those recorded by Moustafa *et al*. (2006). The results show that raising magnesium levels from

Table 10: **Root and sugar yields (t/fed) as affected by potassium and magnesium fertilization levels in 2013/2014 and 2014/2015 seasons**.

Characters / Treatments	Root yield (t/fed) 1st season	Root yield (t/fed) 2nd season	Sugar yield (t/fed) 1st season	Sugar yield (t/fed) 2nd season
K_2SO_4 levels (kg/fed)				
50	25.48	25.66	3.89	3.97
75	26.57	26.54	4.24	4.30
100	26.05	26.32	4.19	4.33
LSD at 0.05 level	**NS**	**NS**	**NS**	**0.21**
$MgSO_4$ levels (kg/fed)				
Without Mg	25.08	25.79	3.80	3.99
20	25.90	26.06	4.05	4.18
50	26.41	26.32	4.19	4.24
80	26.73	26.53	4.39	4.38
LSD at 0.05 level	**0.78**	**0.21**	**0.13**	**0.12**
K x Mg	**	**	**	**NS**

*** 50 kg K_2SO_4 (48% K_2O) equivalent to 24 kg K_2O** *** 20 kg $MgSO_4$ (10% MgO) equivalent to 2 kg MgO**
*** 75 kg K_2SO_4 (48% K_2O) equivalent to 36 kg K_2O** *** 50 kg $MgSO_4$ (10% MgO) equivalent to 5 kg MgO**
*** 100 kg K_2SO_4 (48% K_2O) equivalent to 48 kg K_2O** *** 80 kg $MgSO_4$ (10% MgO) equivalent to 8 kg MgO**

zero to 80 kg resulted in a significant increase in root and sugar yields/fed. Fertilizing beets with 50 and/or 80 kg $MgSO_4$/fed without significant difference between them resulted in higher values of root yield/fed, whilst addition 80 kg achieved significant increase in sugar yield/fed compared to other treatments. Fertilizing beet with 80 kg $MgSO_4$ led to an increase amounted to 1.21%, 0.79% t/fed in root yield and 4.77%, 3.30% t/fed in sugar yield in 1st and 2nd season respectively, as compared to that gained by fertilizing beets with 50 kg $MgSO_4$/fed. These results are probably due to that the amount of Mg in the soil was below the critical limits. So, supplying sugar beet plants with Mg had a significant increase in the yield of root as a result of improving the physiological performance of the treated plants by helping to fix CO_2, enabling more sugar to be produced. Moreover, the positive effect of Mg fertilizer might be due to the increased efficiency of N-fertilization in building up metabolites translocations from leaves to developing roots in crops (especially sugar beet), which showed a significant response to Mg fertilizer supply, with the greatest increase in yield by enhanced nitrogen. These findings are in agreement with those reported by Malnou, *et al*. (2006) and Abou El-Magd *et al*. (2013).

The interaction between potassium and magnesium fertilization levels had a significant effect on root yield/fed in both seasons and sugar yield/fed in 1st season (Table 10).

Interaction effects:

Data in Tables 11 and 12 showed that both root yield/fed in (both seasons) and sugar yield/fed (in 1st season) were significantly influenced by the interaction between potassium and magnesium levels. Feeding beet plants with 75 kg K_2SO_4/fed recorded the highest values of root yield (27.88 and 27.07 t/fed) in 1st and 2nd seasons, respectively and sugar yield/fed (4.51 t/fed). While, applied beet plants with 100 kg K_2SO_4/fed + 80 kg $MgSO_4$/fed came in the second rank. The differences in root and sugar yields/fed of sugar beet fertilized with those rates were mentioned of potassium and magnesium may be due to the positive effect of potassium and magnesium on rate of photosynthesis as shown in Table (2), and transport of the photosynthetic product from leaves to the storage roots which reflected on root and sugar yields/fed (El-Sayed, 2005 and Mehran and Samad, 2013).

Table 11: **Root yield (t/fed) as affected by the interaction between potassium and magnesium fertilization levels in 2013/2014 and 2014/2015 seasons**.

Treatments	2013/ 2014 season				2014/ 2015 season			
	Without Mg (control)	**20 kg $MgSO_4$**	**50 kg $MgSO_4$**	**80 kg $MgSO_4$**	**Without Mg (control**	**20 kg $MgSO_4$**	**50 kg $MgSO_4$**	**80 kg $MgSO_4$**
50 kg K_2SO_4	23.45	25.22	26.22	27.02	25.10	25.37	25.77	26.43
75 kg K_2SO_4	25.85	26.21	26.32	27.88	26.03	26.43	26.63	27.07
100 kg K_2SO_4	25.93	26.27	26.71	25.28	26.23	26.37	26.57	26.10
LSD at 0.05% level for :				**1.54**				**0.49**

*** 50 kg K_2SO_4 (48% K_2O) equivalent to 24 kg K_2O** *** 20 kg $MgSO_4$ (10% MgO) equivalent to 2 kg MgO**
*** 75 kg K_2SO_4 (48% K_2O) equivalent to 36 kg K_2O** *** 50 kg $MgSO_4$ (10% MgO) equivalent to 5 kg MgO**
*** 100 kg K_2SO_4 (48% K_2O) equivalent to 48 kg K_2O** *** 80 kg $MgSO_4$ (10% MgO) equivalent to 8 kg MgO**

Table 12: **Sugar yield (t/fed) as affected by the interaction between potassium and magnesium fertilization levels in 2013/2014 season**.

Treatments	2013/2014 season			
	Without Mg (control)	20 kg $MgSO_4$	50 kg $MgSO_4$	80 kg $MgSO_4$
50 kg K_2SO_4	3.37	3.73	4.00	4.47
75 kg K_2SO_4	3.97	4.22	4.26	4.51
100 kg K_2SO_4	4.07	4.19	4.30	4.18
LSD at 0.05% level for :				**0.36**

*** 50 kg K_2SO_4 (48% K_2O) equivalent to 24 kg K_2O**
*** 75 kg K_2SO_4 (48% K_2O) equivalent to 36 kg K_2O**
*** 100 kg K_2SO_4 (48% K_2O) equivalent to 48 kg K_2O**
*** 20 kg $MgSO_4$ (10% MgO) equivalent to 2 kg MgO**
*** 50 kg $MgSO_4$ (10% MgO) equivalent to 5 kg MgO**
*** 80 kg $MgSO_4$ (10% MgO) equivalent to 8 kg MgO**

Generally, further study is needed on the effect of interaction between Mg and K in relation to their effects on the uptake and translocation of Mg under sandy soils conditions which, suffer and/or sufficient in potassium to realize the maximum beet root and sugar yields/fed with satisfactory quality.

REFRANCES

A.O.A.C. (2005). Association of official analytical chemists. Official methods of analysis, 26th Ed. AOAC Int., Washington, D.C; USA.

Abou El-Magd, B.M.; M. Seham Abd El-Azeem and O.A.M. Ali (2013). Impact of compost and foliar spry with magnesium on some soil properties, photosynthetic pigments and sugar beet crop quality. Minufiya J. Agric. Res., 6 (2): 1481-1500.

Amer, M.A.; M.Z. Attalah; M.F. Ibrahim and F. El-Taweel (2004). Effect of potassium fertilizer on mineral contents and some biological components of ten sugar beet varieties. J. Agric. Sci., Mansoura Univ., 29 (6): 2963-2978.

Black, C. A.; Evans D.D.; L.E. Ensminger; G.L. White and F.E. Clark (1981). Methods of soil analysis. Part 2. Pp. 1-100. Agron. Inc. Madison. WI., USA.

Bohra, S.; N. Mathur; J. Singh; A. Bohra and A. Vyas (2006). Hanges in morph-biochemical charateristics of Moth bean in Indian Thar Desert-due to sulphur and iron nutrition. Amer-Eurasian J. Agric. & Environ. Sci., 1 (1): 51-57.

Cakmak, I. and E.A. Kirkby (2008). Role of magnesium in carbon partitioning and alleviating photooxidative damage. Plant Physiol., 133: 692–704.

Carter, J. N. (1986). Potassium and sodium uptake effects on sucrose concentration and quality of sugar beet roots. J. Am. Soc. Sugar Beet Technol., 23 (3-4): 183-202.

Celik, H.; B. Kunter; G. Soylemezoglu; A. Ergul; H. Karatas; G. Ozdemir and A. Atak (2010). Methods development of viticulture and production targets. TZM VII. Tech., Conf., 11-15 Jan. Ankara, Turkey 493-513.

Chapman, H.D. and P.F. Pratt (1978). Methods of analysis for soils, plants and waters. Division of Agricultural Sciences, University of California, Berkeley, USA, 3043 pp.

Cooke, D. A. and R. K. Scott (1993). The Sugar Beet Crop. Science Practice. Puplished by Chapman and Hall, London.

Devillers, P. (1988). Prevision du sucre melasse. Scurries francases 129: 190-200. (C. F. The Sugar Beet Crop Book).

El-Sayed, G.S. (2005). Effect of nitrogen and magnesium fertilization on yield and quality of two sugar beet varieties. Egypt. J. Agric. Res., 83:709–724.

Enan, S.A.A.M. (2011). Effect of transplanting and foliar fertilization with potassium and boron on yield and quality traits of sugar beet sown under saline conditions. J. Biol. Chem. Environ. Sci., 6 (2): 525-546.

Gomez, K.A. and A.A. Gomez (1984). Statistical procedures for agriculture research. 2nd Ed., "A Wiley Interscience Publication", John Wiley and Sons, New Youk.

Hermans, C.; F. Bourgis; M. Faucher; R.J. Strasser; S. Delrot and N. Verbruggen (2005). Magnesium deficiency in sugar beets alters sugar partitioning and phloem loading in young mature leaves. Planta, 220: 541–549.

Hermans, C.; J.P. Hammond; P.J. White and N. Verbruggen (2006). How to plants respond to nutrient shortage by biomass allocation? Trends Plant Sci., 11: 610-617.

Jackson, M. I. (1973). Soil chemical analysis. Prentice Hall Inc. Englewood cliffs, N. J., U.S.A.

Ma, T.S. and C. Zuazage (1942). Micro-Kjeldahl determination of nitrogen a new indicator and an improved repaid method. Industr. Eng. Chem. Anal. Ed. 14, 280.

Malnou, C.S.; K.W. Jaggard and D.L. Sparkes (2006). A canopy approach to nitrogen fertilizer recommendation for the sugar beet crop. Eur. J. Agron., 25:254–263.

Marschner, H. (2012). Mineral nutrition of higher plants, (Third Edition). Academic Press, London.

Mehran, S. and S. Samad (2013). Study of potassium and nitrogen fertilizer levels on the yield of sugar beet in jolge cultivar. J. Appl. Sci., 2 (4): 94-100.

Moustafa, Zeinab, R.; N. Shafika and A.A. El-Masry (2006). Effect of nitrogen and potassium fertilization with or without spraying by iron combined with manganese on some physio-chemical properties, productivity and quality of sugar beet crop. Annals Agric. Sci., Moshtohor 44 (4): 1431-1446.

Osman, M.S.H. (2005). Effect of potassium and magnesium on yield and quality of two sugar beet varieties. Egypt. J. Agric. Res., 83 (1): 215-228.

Pakrasi, H.; T. Ogawa and M.Bhattacharrya-Pakrasi (2001). Transport of metals: a key process in oxygenic photosynthesis. In: Eva-Mari Aro and Bertil Anderson (eds): Regulation of photosynthesis. Kluwer, Acad. 11: 253–264.

Shaul, O. (2002). Magnesium transport and function in plants. The tip, of the iceberg. Bio-Metals, 15: 307–321.

Snedecor, G.W. and W.G. Cochran (1980). Statistical Methods. 7th Ed. The Iowa State Univ. Press Amer. Iowa, USA.

Wettstein, D. (1957). Chlorophyll, Letal_und der submikro svopische formmech, sall-plastiden. Exptl Cell Ser., 12: 427-433 (C.F. Crop Sci., 37: 383-390.

إستجابة بنجر السكر لمستويات مختلفة من التسميد البوتاسي والماغنسيومي تحت ظروف الأراضي الرملية

صلاح علي عبد اللاة محمود عنان

قسم بحوث المعاملات الزراعية – معهد بحوث المحاصيل السكرية – مركز البحوث الزراعية - الجيزة.

أقيمت تجربتان حقليتان فى وادي النطرون- محافظة البحيرة (دائرة عرض ٣٠.٤٨ ° شمالاً و خط طول ٣٠.٥٠ ° شرقاً) في موسمى ٢٠١٤/٢٠١٣ و ٢٠١٥/٢٠١٤ لدراسة تأثير ثلاثة مستويات من كبريتات البوتاسيوم هي: ١- ٥٠ كجم كبريتات بوتاسيوم/فدان (مقارنةٍ) ، ٢- ٧٥ كجم كبريتات بوتاسيوم/فدان ، ٣- ١٠٠ كجم كبريتات بوتاسيوم/فدان تم إضافتهم فبل تمام التغطية الورقية (حوالي ٧٠ يوماً من الزراعة) ، وأربعة مستويات من الماغنسيوم تم إضافتهم بعد تجهيز الأرض للزراعة وبعد التقسيم الي الوحدات التجريبية هي: ١- بدون إضافة كبريتات الماغنسيوم (مقارنةٍ). ٢- إضافة ٢٠ كجم/ فدان كبريتات ماغنسيوم (١٠ % أكسيد ماغنسيوم). ٣- إضافة ٥٠ كجم/ فدان كبريتات ماغنسيوم (١٠ % أكسيد ماغنسيوم). ٤- إضافة ٨٠ كجم/فدان كبريتات ماغنسيوم (١٠ % أكسيد ماغنسيوم) ، وذلك لدراسة تأثيرها على بعض صفات النمو وحاصل وجودة بنجر السكر. * تم إستخدام تصميم الشرائح المتعامدة في ثلاث مكررات ، حيث إحتلت مستويات البوتاسيوم الشرائح الرأسية ، بينما وزعت مستويات الماغنسيوم في الشرائح الأفقية.أوضحت النتائج ما يلي: ١- أعطي التسميد بمعدل ٧٥ أو ١٠٠ كجم كبريتات بوتاسيوم/فدان زيادة معنوية في متوسطات صفات محتوي الأوراق من (كلورفيل-ب) والكاروتينيدات ، ووزن الجذر/ نبات ، النسبة المئوية للسكروز ، و محتوي الأوراق من البوتاسيوم والماغنسيوم في الموسمين ، فضلاً عن نسبة الجذر الي العرش في الموسم الثاني فقط ، بينما أدي التسميد بعدل ٧٥ كجم كبريتات بوتاسيوم/ فدان إلي الحصول علي أقل القيم لمحتوي الصوديوم والبوتاسيوم والألفا أمينو نيتروجين في العصير ، وأعلي القيم لمؤشر دليل جودة العصير والسكر المستخلص في الموسمين. - لم يتأثر محتوي الأوراق من (كلورفيل- أ) و قطر الجذر ووزن الأوراق/نبات و محتوي الأوراق من النيتروجين والفوسفور بالإضافة الي نسبة الجذر إلي العرش و الماغنسيوم الممتص بالجذور بمستويات البوتاسيوم المستخدمة في الموسمين. ٢- أدي التسميد بمعدل ٨٠ كجم كبريتات ماغنسيوم/فدان إلي زيادة معنوية في محتوي الأوراق من صباغات البناء الضوئي ووزن الجذور والأوراق الطازجة/ نبات ونسبة الجذر إلي العرش وكذلك محتوي الأوراق من النيتروجين والفوسفور والبوتاسيوم والممتص من الماغنسيوم في الجذور و النسبة المئوية لكلٍ من لسكروز وناتج السكر ومؤشر الجودة في الموسمين ، فضلاً عن الحصول علي أقل قيمة للسكر المفقود في المولاس بالمقارنة بباقي المعاملات المستخدمة. - لم يتأثر محتوي الجذور من الصوديوم والبوتاسيوم بمستويات الماغنسيوم المستخدمة في الموسمين. ٣- تأثر محتوي الأوراق من (كلورفيل-أ) و قطر الجذر و محتوي الأوراق من النيتروجين و كذلك حاصل الجذور/فدان في الموسمين ، فضلاً عن حاصل السكر/فدان (في الموسم الأول) بالتفاعل بين مستويات تسميد نباتات بنجر السكر بكبريتات البوتاسيوم والماغنسيوم ، حيث تم الحصول علي أعلي القيم لحاصل الجذور (٢٧.٨٨ و ٢٧.٠٧ طن/ فدان) في الموسمين علي الترتيب ، فضلاً عن (٤.٥١ طن/ سكر للفدان) في الموسم الأول ، وذلك عند إضافة ٧٥ كجم كبريتات بوتاسيوم/ فدان مع التسميد بمعدل ٨٠ كجم كبريتات ماغنسيوم/ فدان.

توصي الدراسة بتسميد بنجر السكر بإضافة ٧٥ كجم كبريتات بوتاسيوم/فدان مع ٨٠ كجم كبريتات ماغنسيوم/فدان تحت ظروف الأراضي الرملية المروية بالرش بوادي النطرون للحصول علي أعلي عائد من حاصل الجذور والسكر طن/فدان.