FACULTY OF AGRICULTURE

Minia J. of Agric. Res. & Develop.
Vol. (28) No. 3 pp 495 - 518, 2008

RESPONSE OF SUGAR BEET TO N, K, AND Na APPLICATIONS IN NEWLY RECLAIMED SOILS OF MINIA GOVERNORATE

A. M. Telep* ; A.U. Lashin* ; S.A. Ismail* and G.F.H. El-Seref**

*Soil Science Department, Faculty of Agriculture, Minia University, El-Minia, Egypt

**Soil Science, Water and Environment Res. Inst., Agric. Res. Center, Seds, Egypt.

Received 29 July 2008 Accepted 31 August 2008

ABSTRACT

Two field experiments were conducted in newly reclaimed soils, Beni Mazzar district, Minia Governorate, Egypt, to study the effect of nitrogen (0, 70 and 140 kg N/fed), potassium (0, 48 and 96 kg K_2O/fed) and sodium (0, 75 and 150 kg Na/fed) applications on yield and juice quality of sugar beet (Oscar Variety). The combination between the levels of the studied factors were arranged in a randomized complete block design of four replications.

Results showed that increasing nitrogen level up to 140 kg N/fed resulted in an increases in root yield, sugar yield, total soluble solids, alpha-amino nitrogen and potassium content in the juice, while, sucrose content, purity percentage and sodium content in the juice decreased. Potassium application significantly increased root yield, sugar yield, total soluble solids and potassium content in the juice, while, sucrose content, purity percentage and sodium content in the juice responded negatively. Sodium application significantly increased root yield, sugar yield, total soluble solids and sodium content in the juice, but purity percentage and the potassium content in the juice responded negatively. However, Na application had no effect on sucrose percentage.

The interaction between potassium and sodium significantly affected root yield/fed and sugar yield. In that respect, sodium application significantly increased these

parameters only in absence of potassium, while under 48 or 96 kg K_2O/fed, the application of sodium did not affect the yield parameters. This means that sugar beet plants could use sodium instead of potassium under low potassium levels in the soil.

From this study, it could be recommended; to obtain the highest root and sugar yield under newly reclaimed soil condition of Minia Governorate, sugar beet plants could be fertilized with 140 kg N and 96 kg K_2O without sodium application or 140 N and 75 kg Na/fed in the absence of potassium in addition to the other recommendation pakegs for sugar beet plants under sandy soils.

INTRODUCTION

In Egypt, the importance of sugar beet arises not only from being the second source for sugar production after sugar cane but also for the ability to grow well in newly reclaimed soils, which usually suffer from salinity and poor quality of irrigation water. Sugar beet quality is of great economic importance(El-Dosouky and Attia, 2004). This holds for both, the factory which is interested in obtaining the maximum output of refined sugar and for the farmer who wants to obtain high income for his beet if meets quality standards set by the factory. The farmers try to get both good yield and high quality in order to gain the maximum return and profit (Ewis, 2004). The total cultivated area by sugar beet in Egypt amounted to 186.000 feddan in 2005/2006 season. It produced about 38967.000 tons of roots with an average of 20.95 tons/fed. Recently, the production of sugar is not adequate enough to the consumption. Therefore, more attention has been paid to grow and develop sugar beet crop to reduce the gap between the consumption and the production.

Nitrogen is the nutrient element that most frequently limits yields in the tropics as well as in the temperate regions. It has a role in building up plant organs through the synthesis of proteins and it is an integral part of the chlorophyll molecule. Also, it is important in the synthesis of sucrose and in the reactions involving the utilization of sucrose as an energy source for plant growth and cell maintenance (El-Maghraby et al., 1998 and El- Harriri and Gobarh, 2001). In soils of different fertility status whereas increasing N inputs caused increases in root yield, the effect of N on quality and sugar production is more complex, because plant with an increased N supply diverts more energy from stored sugar (sucrose) to be used in root growth. Thus, N can have opposite effects on both concentration and accumulation of amino N compounds which determine the extractability of sugar during processing. It is relevant, therefore, to quantify this effect of N on yield and quality of sugar beet for a specific soil environment.

Potassium is a mobile element in plant tissues and plays an important role in photosynthesis through carbohydrate metabolism, osmotic regulation, nitrogen uptake, protein synthesis and translocation of assimilates. Its role in the physiological processes in the plant such as respiration, translocation of sugar and carbohydrates, energy transformation and enzyme actions is also known. Potassium is normally the major osmoticum in plant cells and plays a major role in the maintenance of turgor, stomatal control and the regulation of plant water content (Hsiao and Lauchli, 1986). In additions to the biophysical role, K fulfils biochemical function in the cytoplasm activating numerous enzymes (Wyn, Jones and Pollard, 1983). Many investigations provided evidence for the role of potassium in improving juice quality and sugar recovery of sugar beet. However, potassium fertilization must be adjusted with some care since the excessive levels can have an adverse effect.

Sodium is not an essential element for any crop, even for salt marsh plants. However, certain crops undoubtedly grow better in the presence of available sodium supplies than in their absence. Sodium in these cases appears to carry out some of the functions that potassium usually fulfils. Crops can be divided into four types with respect to their relative needs for sodium compared to potassium, some crops need sodium for optimum growth such as sugar beet, some crops benefit if available sodium is present, some crops can tolerate part of their potassium supply being replaced by sodium and some crops can make no use of sodium even if potassium supply is restricted. The role of sodium in plants is not known, though one of its effects is to increase the succulence of the plant, that is, the amount of water held by unit dry weight of leaf tissue. This may be the reason why it appears to increase the drought resistance of these plants. It also increases the leaf area of sugar beet. Another role of sodium is helping crops to grow in potassium-deficient soil that prevents an accumulation of other cations that may be toxic to the plant, as a deficiency of one cation lead to an accumulation of others. Sugar beet is probably the most sodium demanding crop and needs a reasonable potassium supply for proper growth. If the minimum potassium supply has been provided, it requires a good supply of sodium to produce satisfactory yields.

The objective of the present study was to determine the requirements of sugar beet from nitrogen and potassium as well as sodium and their effects on yield and quality of sugar beet grown in newly reclaimed soils at Minia Governorate.

MATERIALS AND METHODS

This study was conducted in newly reclaimed land at Beni Mazzar district, Minia Governorate, Egypt in two growth seasons of 2003/2004 and 2004/2005 to study the effect of nitrogen, potassium and sodium application on yield and juice quality of sugar beet (*Beta vulgaris* L.).

The experiment was factorial (involving three factors) and laid in a randomized complete block design with four replications. The plot area was 10.5 m^2 (3 m x 3.5 m = 1/400 fed) with 6 rows in apart 50 cm width.

Treatments:

Nitrogen : was added at three levels of 0, 70 and 140 kg N/fed as ammonium nitrate (33.5% N).

Potassium : was added at three levels of 0, 48 and 96 kg K_2O/fed as potassium sulphate (48% K_2O).

Sodium : was added at three levels of 0, 75 and 150 kg Na/fed as a commercial sodium chloride (39% Na).

Seeds of Oscar variety were planted (4 kg/fed) at a distance of 20 cm in hills in the second week of October for both seasons. Thinning was made after 30 days of planting to obtain one plant/hill (about 35000 plants/fed). During seed preparation, phosphorus was added at the level of 31 kg/fed as calcium super phosphate (15.5% P_2O_5). Nitrogen was applied at four equal doses; the first dose was one month after sowing and the other three doses were added at intervals of fifteen days latter. Potassium and sodium were added at two equal doses; the first dose was after thinning and the second one one month latter. The main source of irrigation water was Bahr Yossief River. All other agronomic practices were followed using the technical package of growing sugar beet as described by Sugar Research Institute, Agricultural Research Center, Cairo, Egypt.

Sugar beet plants were harvested in the first week of May in both growing seasons. A representative sample of ten sugar beet plants was randomly taken from the two middle rows of each plot to determined root yield and sugar yield (in tons/fed). Also, a sample of about 10 kg fresh roots was taken from every plot and then transported to Delta Sugar Company Limited Laboratory in Kafr El-Sheikh for the determination of juice quality such as sucrose percentage in roots according to Le Docte (1927), total soluble solids (T.S.S.%) using hand refractometer (A.O.A.C. 1986), impurities (Alpha-amino-N, K and Na in meq/100g) according to the method described by A.O.A.C. (1986) and juice purity (%) using the equation described by Carruthers and Old Field (1961) where: Juice purity (%) = sucrose % / TSS %.

All obtained data of both seasons were recorded on dry weight basis as follows:

- Root fresh yield and gross sugar yield (ton/fed) were calculated as the feddan area is 4200 m^2.
- Sugar yield (ton/fed) was calculated by using the following equation:
- Sugar yield (ton/fed) = root fresh weight x Sucrose (%).
- Nitrogen, phosphorus, potassium and sodium uptake (kg/fed) was calculated by multiplying nutrient concentration % X the root dry yield (ton/fed) x 10.

Composite representative soil samples of the field where the experiments were carried out were taken for analysis and the results are shown in Table 1:

1- Particle size distribution was determined using the pipette method according to Piper (1950).
2- Saturated soil paste extract in which $E.C_e$ (dSm^{-1}), pH, CO_3^{-2}, HCO_3^-, SO_4^{-2}, CL^-, Na^+ and Ca^{++} were determined (Jackson, 1973).
3- Organic matter was determined by using the wet digestion method (Walkley and Black) according to Jackson (1973).

4- Total carbonate was estimated by using calcimeter method (Jackson, 1973).

5- Available N was determined in 1 N KCl soil extract according to Jackson (1973).

6- Available P was extracted by 0.5 M $NaHCO_3$ buffered at pH 8.2 (Olsen *et al.*, 1954) and measured spectrophotometerically as described by Jackson (1973).

7- Available K and Na was extracted using 1.0 N ammonium acetate adjusted at pH 7.0 and determined by flame photometer (Black *et al.*, 1985).

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

Characteristics	First season	Second season
Coarse sand (%)	11.34	6.31
Sand (%)	74.18	76.19
Silt (%)	10.40	11.32
Clay (%)	4.08	6.18
Texture class	Sand	Sand
pH (soil paste)	7.6	7.9
EC_e dSm^{-1} (soil paste)	1.11	1.32
Organic matter (%)	0.29	0.21
$CaCO_3$ (%)	3.10	2.86
Available N (mg kg^{-1})	10.00	8.00
Available P (mg kg^{-1})	4.90	4.1
Available K (mg kg^{-1})	62.00	71.00
Available Na (mg kg^{-1})	110.00	121.00
Soluble cations (meq/100g)		
K^+	2.18	2.17
Na^+	5.51	5.91
Ca^{++}	2.71	3.93
Mg^{++}	0.37	0.93
Soluble anions (meq/100g)		
CO_3^{--}	-	-
HCO_3^-	3.18	3.71
Cl^-	5.15	5.92
SO_4^{--}	2.44	3.31

Statistical analysis:

The data were subjected to the proper statistical analysis of variance according to Snedecor and Cochran (1980). Significance of variance among means was compared using the least significant difference (L.S.D) at the 0.05 level of probability.

RESULTS AND DISCUSSION

Root Fresh Yield:

The effect of nitrogen, potassium and sodium on root fresh yield is shown in Table 2. The application of 0, 70 and 140 kg N/fed resulted in respective average values of root fresh yield of 9.52, 14.64 and 20.66 ton/fed in the first season and 8.25, 13.79 and 19.78 ton/fed in the second season. The main effect of nitrogen reveled that application of nitrogen caused significant increases in root fresh yield. The increase percentage due to applying 70 and 140 kg N/fed reached 53.78 and 117.02%, respectively, in the first season and 67.15 and 139.76%, respectively, in the second season, compared with the control. The increases in yield with adding nitrogen fertilizer correspond to the increases in the root diameter and length, root and shoot fresh weight per plant as well as shoot fresh yield. This accounts for the increase in the amount of metabolites synthesized by plants. The obtained results coincide with those reported by Asad *et al.* (2000), Bauer *et al.* (2001) and Tsialts and Maslaris (2005).

The results indicated that applying K at levels of 48 and 96 kg K_2O/fed increased root fresh yield by 7.66 and 16.18%, respectively, in the first season and 18.13 and 26.13%, respectively, in the second season compared with the control. The increase in root fresh yield with increasing potassium fertilization, could be mainly due to the positive effect on growth characters. Many researches indicated that potassium tended to increase root fresh yield of sugar bet (Ismail and Abo El-Ghait, 2004; Ferweez and El-Wafa, 2004).

With respect to sodium, the results showed that root fresh yield due to the application of 75 kg Na/fed exceeded that of the control by 6.35 and 3.52% for first and second seasons, respectively. The increases due to the application of sodium at levels of 75 and 150 kg Na/fed were somewhat similar. The increment of root fresh yield caused by sodium application could be explained by the effect of sodium on growth characters of sugar beet plants as well as root fresh weight per plant, which in turn increased root fresh yield. Similar results were obtained by Barog *et al.* (2002) and Barog (2004).

Table 2: Root fresh yield (ton/fed) as affected by N, K and Na application.

Treatment		(C) Sodium (kg/fed)							
		1st season				2nd season			
N(kg/fed) (A)	K_2O(kg/fed) (B)	0	75	150	Mean	0	75	150	Mean
0	0	7.04	9.71	9.76	8.84	5.93	6.44	6.49	6.28
	48	9.65	9.75	9.77	9.72	8.84	9.07	9.08	8.10
	96	10.00	9.97	10.02	10.00	9.24	9.89	9.31	9.48
Mean		8.89	9.81	9.85	9.52	8.00	8.47	8.29	8.25
70	0	11.98	14.11	14.15	13.41	10.84	12.37	12.41	11.87
	48	14.18	14.77	14.80	14.58	13.64	13.87	14.37	13.96
	96	16.03	16.00	15.76	15.93	15.84	16.26	14.51	15.54
Mean		14.06	14.96	14.90	14.64	13.44	14.17	13.76	13.79
140	0	17.76	19.99	20.06	19.27	17.57	18.25	18.86	18.22
	48	20.25	20.47	20.47	20.40	20.04	20.24	20.41	0.23
	96	22.11	22.43	22.40	22.31	20.96	20.81	20.86	0.87
Mean		20.04	20.96	20.98	20.66	19.52	19.77	20.04	19.78
Mean of K	0	12.26	14.60	14.66	13.84	11.44	12.35	12.58	12.13
	48	14.69	14.99	15.01	14.90	14.17	14.39	14.62	14.39
	96	15.05	16.13	16.06	16.08	15.35	15.65	14.89	15.30
Mean of Na		14.33	15.24	15.24	14.94	13.65	14.13	14.03	13.94
L.S.D at 0.05									
A		0.22				0.08			
B		0.22				0.08			
C		0.22				0.08			
AB		0.38				0.14			
AC		N.S.				N.S.			
BC		0.38				0.14			
ABC		N.S.				N.S.			

Concerning the interactions between treatments, the obtained data showed that root fresh yield was affected only by the interaction between potassium and sodium. Application of 75 kg Na/fed improved the root fresh yield only in the absence of potassium. Increasing Na level from 75 to 150 kg Na/fed in absence of K had no effect on root fresh yield, where the difference between the two treatments was not significant in both seasons. The relative increases in root fresh yield caused by application of 75 kg Na/fed in absence of potassium reached to 19.09 and 7.95% over the control in the first and second seasons, respectively. In this concern, Hilde *et al.* (1983) mentioned that sodium chloride has been used as K fertilizer substitute in certain humid regions because of its lower cost.

Sugar Yield:

The results in Table 3 show that sugar yield increased significantly with increasing nitrogen levels in both seasons. The increase percentage due to applying 70 and 140 kg N/fed reached to 42.67 and 79.58%, respectively, for the first season and 52.27 and 103.66%, respectively, in the second season. The increment in sugar yield resulted from increasing nitrogen levels could be mainly due to the effect of nitrogen on root parameters. These results are in agreement with those obtained by El-Dosouky and Attia (2004) and Tsialtas and Maslaris (2005).

Concerning potassium fertilization, results revealed that sugar yield responded positively to potassium levels. The values of sugar yield due to applying 0, 48 and 96 kg K_2O/fed were 2.54, 2.70 and 3.11 ton/fed, respectively, in the first season and 2.22, 2.67 and 2.93 ton/fed, respectively, in the second seasons. This favorable effect of potassium on sugar yield could be mainly due to the increasing in the root parameters with increasing potassium levels. Similar results were obtained by Osman (2005).

Table 3 indicates that increasing sodium level from zero to 75 kg Na/fed increased sugar yield while treated with 75 to 150 kg Na/fed decreased the sugar yield in both seasons. This trend of sugar yield due to increasing sodium levels is parallel to its effect on the root yield as previously discussed. This similarity of sodium effect on root and sugar yields, beside the insignificant effect of sodium on sucrose percentage (it will be discussed later), is a good explanation of sugar yield increment owing to sodium application, since sugar yield calculated as multiplying the root yield with sucrose percentage.

Regarding the interaction effect, in general, sugar yield was affected by the interactions between treatments, where the highest value of sugar yield was obtained by sugar beet plants fertilized with 140 kg N/fed and 96 kg K_2O/fed without sodium application.

Table 3: Sugar yield (ton/fed) as affected by N, K and Na application.

Treatment		(C) sodium (kg/fed)							
		1st season				2nd season			
N (kg/fed) (A)	K_2O (kg/fed) (B)	0	75	150	Mean	0	75	150	Mean
0	0	1.45	2.07	2.09	1.87	1.19	1.29	1.32	1.27
	48	1.78	2.03	2.01	1.94	1.87	1.89	1.83	1.86
	96	2.16	2.11	2.11	2.13	1.97	2.09	1.98	2.01
Mean		1.80	2.07	2.07	1.98	1.68	1.76	1.71	1.71
70	0	2.25	2.75	2.68	2.56	2.05	2.33	2.35	2.24
	48	2.73	2.76	2.72	2.73	2.55	2.58	2.66	2.60
	96	3.24	3.22	3.07	3.18	3.04	3.14	2.79	2.99
Mean		2.74	2.91	2.82	2.82	2.55	2.68	2.60	2.61
140	0	2.88	3.36	3.32	3.19	3.01	3.16	3.27	3.15
	48	3.45	3.47	3.37	3.43	3.44	3.63	3.59	3.55
	96	4.12	4.05	3.95	4.04	3.75	3.75	3.82	3.78
Mean		3.48	3.63	3.55	3.55	3.40	3.51	3.56	3.49
Mean of K	0	2.19	2.73	2.70	2.54	2.08	2.26	2.31	2.22
	48	2.65	2.75	2.70	2.70	2.62	2.70	2.70	2.67
	96	3.17	3.13	3.04	3.11	2.92	2.99	2.86	2.93
Mean of Na		2.67	2.87	2.81	2.79	2.54	2.65	2.62	2.61
L.S.D at 0.05									
A		0.09				0.07			
B		0.09				0.07			
C		0.09				0.07			
AB		0.15				0.12			
AC		0.15				0.12			
BC		0.15				0.12			
ABC		0.21				0.17			

Sucrose Content Percentage:

Table 4 clearly shows that nitrogen fertilization with 70 and 140 kg N/fed decreased sucrose percentage by 2.02 and 3.94%, respectively, in the first season and by 1.79 and 3.07%, respectively, in the second season compared with the control. The reduction in sucrose percentage due to increasing nitrogen levels could be explained by the fact that excess nitrogen levels increased nitrogen uptake which in turn making plant tops dominant photosynthate sink at the expense of plant roots and by changing the concentration and proportion of root K and Na.

Table 4: Sucrose percentage as affected by N, K and fertilization.

Treatments		(C) sodium (kg/fed)							
		1st season				2nd season			
N(kg/fed) (A)	K_2O(kg/fed) (B)	0	75	150	Mean	0	75	150	Mean
0	0	20.55	21.30	21.45	21.10	20.09	20.11	20.31	20.17
	48	21.42	20.82	20.58	20.94	21.13	20.82	20.19	20.72
	96	21.59	21.21	21.05	21.28	21.13	21.11	21.28	21.23
Mean		21.19	21.11	21.02	21.11	20.84	20.68	20.60	20.71
70	0	18.78	19.51	18.98	19.09	18.91	18.80	18.92	18.88
	48	19.18	18.63	18.36	18.74	18.73	18.63	18.53	18.63
	96	20.34	20.10	19.46	19.93	19.17	19.31	19.56	19.25
Mean		19.40	19.43	18.93	19.25	18.94	18.91	18.90	18.92
140	0	16.26	16.84	16.56	16.55	17.12	17.32	17.34	17.26
	48	17.09	16.98	16.45	16.84	17.15	17.93	17.62	17.57
	96	18.65	18.07	17.65	18.12	17.91	18.04	18.31	18.09
Mean		17.33	17.30	16.88	17.17	17.39	17.76	17.76	17.64
Mean of K	0	18.53	19.22	18.99	18.91	18.71	18.74	18.86	18.77
	48	19.23	18.82	18.46	18.84	19.00	19.13	18.78	18.97
	96	20.15	19.80	19.39	19.78	19.47	19.49	19.62	19.52
Mean of Na		19.31	19.28	18.95	19.18	19.06	19.12	19.09	19.09
L.S.D at 0.05									
A		0.90				0.74			
B		N.S.				N.S.			
C		N.S.				N.S.			
AB		N.S.				N.S.			
AC		N.S.				N.S.			
BC		N.S.				N.S.			
ABC		N.S.				N.S.			

Increasing Na concentration or decreasing K: Na ratio by increasing N uptake, or by other means, increases the root water concentration and reduce the sucrose concentration. High sucrose concentration and root quality were generally associated with low to moderate N uptake, low Na concentration, high K: Na ratio, and low water concentration in the root and vice versa (Carter, 1986a). These results are in a good agreement with those obtained by Hoffman (2005). For potassium, it can been seen that potassium fertilization improved sucrose content in sugar beet juice. The values of sugar content related to 0, 48 and 96 kg K_2O/fed were 18.91, 18.84 and 19.78%, respectively, in the first season and 18.77, 18.97 and 19.52%, respectively, in the second season. It is worthy to notice that sucrose content responded to potassium levels only at 96 kg K_2O/fed, where the difference between 0 and 48 kg K_2O/fed was not significant.

Sucrose percentage due to applying 96 kg K_2O/fed exceeded that of the control by 0.78 and 0.75% in the first and second seasons, respectively. These increases in sucrose percentage could be mainly due to that potassium is used in phosphorase enzyme to form sucrose (Ewis, 2004).

With respect to sodium application, results showed that sucrose content did not respond to sodium application. These results are in line with those obtained by Hoffman (2005) who reported that sodium chloride sprayed at concentration of 12% had no effect on the concentration of sugar in sugar beet juice.

Concerning the interaction effect, results clearly showed that sucrose content was not affected by the interactions between treatments whether with the two way interactions or the three way interaction.

Total Soluble Solids (TSS) Content:

Data presented in Table 5 show that TSS. increased with increasing nitrogen levels. The percentage of increase in TSS. caused by the application of 70 and 140 kg N/fed were 6.77 and 16.98%, respectively, in the first season and 6.80 and 16.46%, respectively, in the second season over the control level. Similar results were obtained by El-Maghraby *et al.* (1998) who stated that increasing the level of nitrogen to 90 kg/fed as a soil application or to 1.5% as a foliar spray caused a significant increase in total soluble solids of the juice of sugar beet plants.

For potassium, mean values of total soluble solids resulted from the application of zero, 48 and 96 kg K_2O/fed were 24.86, 25.82 and 26.34%, respectively, in the first season and 24.90, 25.85 and 26.24%, respectively, in the second one. Similar results were obtained by Ferweez and El-Wafa (2004) and Ahmed (2005).

With respect to sodium, obtained results showed that the percentage of total soluble solids in sugar beet juice was not affected by sodium application. The values of TSS caused by sodium treatments of 0, 75 and 150 kg Na/fed were 25.45, 25.84 and 25.74%, respectively, in the first season. Meanwhile, the corresponding values in the second season were 25.52, 25.76 and 25.71%. However, total soluble solids were not affected by any of the two way interactions

(NxK, NxNa or KxNa), or the three way interaction among the three studied variables (NxKxNa).

Table 5: Total soluble solids as affected by N, K and Na application.

Treatment		(C) Sodium (kg/fed)							
		1st season				2nd season			
N(kg/fed) (A)	K_2O (kg/fed) (B)	0	75	150	Mean	0	75	150	Mean
0	0	22.11	23.94	23.03	23.03	22.0	23.59	23.62	23.07
	48	23.94	24.18	23.98	24.03	23.91	24.21	24.34	24.15
	96	24.11	24.40	24.41	24.31	24.34	24.62	23.75	24.23
Mean		23.39	24.17	23.80	23.79	23.42	24.14	23.90	23.82
70	0	24.30	24.74	24.65	24.56	24.56	24.77	24.52	24.62
	48	24.91	25.16	25.42	25.16	25.81	25.12	25.22	25.38
	96	26.33	26.89	26.21	26.48	26.10	26.53	26.33	26.32
Mean		25.18	25.60	25.43	25.40	25.49	25.47	25.35	25.44
140	0	26.78	26.81	27.36	26.98	26.91	26.96	27.19	27.02
	48	28.25	28.31	28.25	28.27	27.96	27.95	28.12	28.01
	96	28.30	28.09	28.33	28.24	28.10	28.12	28.33	28.18
Mean		27.77	27.74	27.98	27.83	27.66	27.68	27.88	27.74
Mean of K	0	24.40	25.16	25.01	24.86	24.49	25.10	25.11	24.90
	48	25.70	25.88	25.88	25.82	25.90	25.76	25.89	25.85
	96	26.24	26.46	26.32	26.34	26.18	26.42	26.13	26.24
Mean of Na		25.45	25.84	25.74	25.67	25.52	25.76	25.71	25.66
L.S.D at 0.05									
A		0.28				0.26			
B		0.28				0.26			
C		N.S.				N.S.			
AB		N.S.				N.S.			
AC		N.S.				N.S.			
BC		N.S.				N.S.			
ABC		N.S.				N.S.			

Juice Purity:

Table 6 clearly shows that increasing nitrogen levels depressed juice purity in both seasons. The highest values of juice purity were recorded for sugar beet plants that did not receive nitrogen fertilization in both seasons (88.88 and 86.84%, respectively), while the lowest ones were for sugar beet plants that were fertilized by 140 kg N/fed in both seasons (63.33 and 63.86 %, respectively).

Table 6: Juice purity percentage as affected by N, K and Na application.

Treatment		(C) Sodium (kg/fed)							
		1st season				2nd season			
N (kg/fed) (A)	K_2O (kg/fed) (B)	0	75	150	Mean	0	75	150	Mean
0	0	93.05	88.95	93.30	91.77	91.25	84.73	83.55	86.51
	48	89.50	86.25	85.93	87.23	88.40	86.03	84.50	86.31
	96	89.73	86.98	86.28	87.66	87.60	85.78	89.70	87.69
Mean		90.76	87.39	88.50	88.88	89.08	85.51	85.92	86.84
70	0	77.43	78.85	76.90	77.73	77.03	75.88	77.23	76.71
	48	80.38	75.58	72.55	76.17	72.60	74.18	73.48	73.42
	96	76.80	74.75	74.25	75.27	73.45	72.13	73.13	72.90
Mean		78.20	76.39	74.57	76.39	74.36	74.06	74.61	74.34
140	0	60.93	63.10	60.48	61.50	66.18	64.08	63.78	64.68
	48	65.65	60.10	67.20	64.32	61.35	64.18	62.65	62.73
	96	66.00	64.33	62.30	64.21	63.78	64.13	64.68	64.19
Mean		64.19	62.51	63.33	63.34	63.77	64.13	63.70	63.86
Mean of K	0	77.13	76.97	76.89	77.00	78.15	74.89	74.85	75.96
	48	78.51	73.98	75.23	75.90	74.12	74.79	73.54	74.15
	96	77.51	75.35	74.28	75.71	74.94	74.01	75.83	74.93
Mean of Na		77.72	75.43	75.46	76.20	75.74	74.56	74.74	75.01
L.S.D at 0.05									
A		2.60				1.08			
B		N.S.				1.08			
C		N.S.				N.S.			
AB		N.S.				N.S.			
AC		N.S.				N.S.			
BC		N.S.				1.33			
ABC		N.S.				N.S.			

This decrease may be due to the excessive amounts of nitrogen which stimulated beet plants to transfer more photosynthates to the top resulting in a decrease in the purity percentage. Similar results were obtained by Ramadan (1997) who found that purity percentage decreased with increasing N levels.

Concerning potassium, it is obvious to notice that juice purity negatively responded to potassium fertilization in the second season only. Raising potassium levels from zero to 48 and 96 kg K_2O/fed decreased purity percentage by 1.81 and 1.03%, respectively. The difference between 48 and 96 kg K_2O/fed treatments was not significant. A slight decreases in purity percentage was also noticed due to applying 48 or 96 kg K_2O/fed but it was not significant in the first season. These results are in harmony with those obtained by El-

Maghraby *et al.* (1998) who reported that a further increase in potassium fertilizer up to 48 kg K_2O/fed caused a significant decrease in purity percentage. On the other hand, Ramadan (1997) and Ewis (2004) found that purity percentage was improved with increasing the K level.

For sodium, results showed that purity percentage in sugar beet juice was not significantly influenced by sodium application in both seasons. It can be noticed that application of 75 or 150 kg Na/fed caused a slight insignificant decrease in purity percentage compared with that without adding sodium in both seasons.

With regard to the interaction, obtained data showed that purity percentage was affected only by the interaction between potassium and sodium in the second season. On the other hand, purity percentage was not affected by the other interactions between the studied treatments.

Alpha-Amino Nitrogen Concentration in Juice:

The soluble nitrogen (N) components in sugar beet seriously impair sugar recovery. The only N components that is determined routinely in sugar factory is amino N (the sum of amino acids in the beet), which is assumed to reflect all other N components.

Table 7 reveals that the concentration of α-amino N increased considerably with increasing N supply in both seasons. The same trend was obtained in the second season. The unlikely effect on α-amino N caused by the excessive nitrogen fertilization could be explained by increasing the role of photosynthesis as well as formation of protein and amino acids (Hoffman, 2005). Similar results were obtained by Bell *et al.* (1995).

Regarding potassium, α-amino N in sugar beet juice tended significantly to decrease up to the highest level of potassium applied in this study. These results mean that control treatment gave higher value, while higher K_2O level resulted in the lower value. El-Harriri and Gobarh (2001) stated that higher level of K_2O depressed the alpha amino nitrogen content of sugar beet quality.

Table 7: Alpha-amino nitrogen in juice (meq/100g) as affected by N, K and Na application.

Treatment		(C) Sodium (kg/fed)							
		1[st] season				2[nd] season			
N(kg/fed) (A)	K_2O(kg/fed) (B)	0	75	150	Mean	0	75	150	Mean
0	0	1.62	1.74	1.80	1.72	1.56	1.64	1.78	1.66
	48	1.55	1.62	1.78	1.65	1.58	1.69	1.84	1.70
	96	1.25	1.31	1.52	1.36	1.40	1.44	1.56	1.47
Mean		1.47	1.55	1.70	1.58	1.51	1.59	1.73	1.61
70	0	1.80	2.00	2.30	2.03	1.90	2.12	2.37	2.13
	48	1.64	1.88	2.02	1.85	1.70	2.06	1.96	1.91
	96	1.25	1.51	1.62	1.46	1.34	1.58	1.64	1.52
Mean		1.56	1.80	1.98	1.78	1.64	1.92	1.99	1.85
140	0	2.14	2.41	2.64	2.40	2.02	2.40	2.58	2.33
	48	2.16	2.23	2.44	2.28	2.12	2.32	2.62	2.35
	96	1.47	2.00	2.22	1.99	1.41	2.16	2.02	1.86
Mean		2.01	2.21	2.43	2.22	1.38	1.72	1.74	2.18
Mean of K	0	1.85	2.05	2.25	2.05	1.83	2.05	2.24	2.04
	48	1.78	1.91	2.08	1.92	1.80	2.03	2.14	1.99
	96	1.41	1.61	1.79	1.60	1.38	1.72	1.74	1.62
Mean of Na		1.68	1.85	2.04	1.86	1.67	1.93	2.04	1.88
L.S.D at 0.05									
A		0.06				0.16			
B		0.06				0.16			
C		0.06				0.16			
AB		N.S.				N.S.			
AC		N.S.				N.S/			
BC		N.S.				N.S.			
ABC		N.S.				N.S.			

For sodium, results showed a remarkable significant increase in this parameter with increasing sodium level up to 150 kg Na/fed, which interfered with the crystallization process in sugar refining.

It is clear that the interaction effects of nitrogen, potassium and sodium application levels on the α-amino nitrogen were not great enough to reach the significant level at 5% during both growing seasons.

Potassium Content in Juice:

Both K and Na in juice are impurities and their presence interferes with the crystallization process in sugar refining. Higher levels of K and Na cause a greater proportion of sugar to be recovered as molasses are reduced in the refined sugar.

With regard to nitrogen, Table 8 shows that the K content in the juice responded significantly to different nitrogen levels. It can be seen that increasing the nitrogen level showed a significant increase in the K content of juice in both seasons. In this respect, many workers obtained similar results, however, El-Harriri and Gobarh (2001) showed that increasing the nitrogen level gave higher values of K content in sugar beet juice.

Table 8: Potassium content in juice (meq/100g) as affected by N, K and Na application.

Treatment		(C) Sodium (kg/fed)							
		1st season				2nd season			
N(kg/fed) (A)	K_2O (kg/fed) (B)	0	75	150	Mean	0	75	150	Mean
0	0	4.68	4.59	4.53	4.60	4.12	4.21	4.33	4.22
	48	5.62	5.38	5.09	5.36	5.56	5.13	4.95	5.21
	96	6.05	5.69	5.59	5.78	6.21	6.07	5.77	6.01
Mean		5.45	5.22	5.07	5.25	5.30	5.13	5.01	5.15
70	0	5.36	5.04	4.75	5.05	5.12	5.21	5.32	5.21
	48	5.82	5.54	5.42	5.59	5.85	5.74	5.68	5.76
	96	6.39	6.08	5.84	6.10	6.42	6.54	6.62	6.53
Mean		5.85	5.55	5.34	5.58	5.79	5.83	5.87	5.83
140	0	5.95	5.62	5.11	5.56	5.90	5.91	6.02	5.94
	48	6.26	6.09	5.85	6.06	6.17	6.32	6.37	6.28
	96	7.04	6.78	6.36	6.73	6.74	6.82	6.77	6.78
Mean		6.41	6.16	5.77	6.12	6.27	6.35	6.39	6.33
Mean of K	0	5.33	5.08	4.79	5.07	5.05	5.11	5.22	5.13
	48	5.90	5.67	5.45	5.67	5.86	5.73	5.67	5.75
	96	6.49	6.18	5.93	6.20	6.46	6.47	6.39	6.44
Mean of Na		5.91	5.64	5.39	5.65	5.79	5.77	5.76	5.77
L.S.D at 0.05									
A		0.319				0.13.			
B		0.319				0.13			
C		0.319				N.S.			
AB		N.S.				N.S.			
AC		N.S.				N.S.			
BC		N.S.				N.S.			
ABC		N.S.				N.S.			

Concerning potassium, it is obvious to notice that K content responded positively to K application. This increase is normally due to the increase in the available K to plants. It is worthy to mention that a high concentration of K in sugar beet juice limits the proportion of sucrose that can be extracted from the beets as a crystalline sugar during factory processing. In this respect, K has a greater effect than sodium (Na) on α-amino N compounds, the other major non-sugar impurities in beet (Milford *et al.*, 2000). Similar results were obtained by Orlovius (1993).

Regarding sodium application, obtained data revealed that K content in the juice was negatively responded to sodium levels only in the first season, while differences between levels in the second season failed to reach the significant value at 5%. The lowest K content was attained by the highest sodium level, i.e. 150 kg Na/fed, while the control level of sodium exerted the highest values of K content in the sugar beet juice.

Hilde *et al.* (1983) mentioned that the depression effect of sodium on K content in the juice may be attributed to that the increase in both availability and uptake of K will meet with decreases Na uptake and vice versa.

For the two ways interactions or the three ways interactions, it can be seen that the effect of these interactions were not great enough to reach the significant level at 5% during both growth seasons.

Sodium Content in Juice:

Data in Table 9 show that sodium content responded positively to the increase in nitrogen levels in both seasons. Similar results were obtained by Carter (1986) who found that impurities in term of Na, K and α-amino nitrogen increased as N level increased. He added that the relationship between Na content and the decreased sucrose concentration resulted from the increased water concentration in the sugar beet plant.

For potassium fertilization, results clearly showed that sodium content in sugar beet juice negatively influenced by potassium fertilization in both seasons. These results agree with those obtained by Ahmed (2005) who indicated that increasing potassium level from zero to 48 kg K_2O/fed significantly decreased sodium concentration in the roots.

With respect to sodium application, obtained results revealed that application of sodium to sugar beet plants significantly increased sodium content in both seasons. This normally due to the increase in the available sodium and in turn increasing its uptake. These results are in line with those obtained by Carter (1986) who showed that applying Na to sugar beet plants increased the Na uptake by roots.

The same data also showed that the sodium content in sugar beet juice was not affected by the interaction effects of the possible combinations for the three studied treatments.

Table 9: Sodium content in juice (meq/100g) as affected by N, K and Na application.

Treatment		(C) Sodium (kg/fed)							
		1st season				2nd season			
N(kg/fed) (A)	K_2O(kg/fed) (B)	0	75	150	Mean	0	75	150	Mean
0	0	4.24	5.35	5.60	5.06	4.69	5.81	5.99	5.49
	48	3.87	4.15	4.43	4.15	3.91	4.62	4.93	4.49
	96	3.88	4.23	4.24	4.12	3.96	4.89	4.97	4.60
Mean		4.00	4.58	4.76	4.44	4.19	5.10	5.30	4.86
70	0	3.86	4.10	4.40	4.12	3.78	4.31	4.62	4.24
	48	4.32	4.50	4.77	4.53	4.13	4.62	4.89	4.55
	96	4.00	4.27	4.67	4.31	3.97	4.34	4.59	4.30
Mean		4.06	4.29	4.61	4.32	3.96	4.42	4.70	4.36
140	0	3.51	3.81	4.03	3.79	3.40	3.91	4.21	3.84
	48	3.03	3.49	3.65	3.39	3.12	3.52	3.92	3.51
	96	2.66	2.37	2.26	2.43	2.81	2.92	2.96	2.90
Mean		3.07	3.22	3.31	3.20	3.10	3.45	3.70	3.42
Mean of K	0	3.87	4.42	4.68	4.32	3.96	4.68	4.94	4.52
	48	3.74	4.05	4.28	4.02	3.72	4.25	4.58	4.18
	96	3.51	3.62	3.72	3.62	3.58	4.05	4.17	3.93
Mean of Na		3.71	4.03	4.23	3.99	3.75	4.32	4.56	4.21
L.S.D at 0.05									
A		0.1				0.16			
B		0.1				0.16			
C		0.1				0.16			
AB		N.S.				N.S.			
AC		N.S.				N.S.			
BC		N.S.				N.S.			
ABC		N.S.				N.S.			

From this study, it could be recommended that to obtain the highest root and sugar yield under the condition of newly reclaimed sandy soils of Minia Governorate, sugar beet plants should be fertilized with 140 kg N and 96 kg K_2O without sodium application or with adding 140 N and 75 kg Na/fed in the absence of potassium in addition to the other recommendation pakegs for sugar beet cultivation in such sandy soils.

REFERENCES

Ahmed, A.F. (2005). Effect of potassium, magnesium and boron on sugar beet yield and quality grown in the newly reclaimed soils. Msc. Thesis, Fac. of Agric., Minia Univ., Egypt.

A.O.A.C. (1986). Official Methods of Analysis 14thh Ed. Association of Official Agricultural Chemists, Alingtan, Virginia, USA.

Asad, M.T.; Kheradnam, M.; Kamkar, Haghighi, A.A.; Karimian, N.A. and Farsinejad, K. (2000). Sugar beet response to N and irrigation levels and time of N application. Iranian Journal of Agricultural sciences, 31(3): 427-443.

Barog, P.; Grzebisz, W.; Gorski, D. and Gaj, R. (2002). Response of high-yielding sugar beet varieties to fertilization with potassium, sodium and magnesium. Biuletyn Instytutu Hodowli i Akiimatyzacji Roslin, (222): 135-142.

Barog, P. (2004). Sugar beet fertilization with potassium, sodium and magnesium-yielding and diagnostic evaluation. Biuletyn Instytutu Hodowli i Akiimatyzacji Roslin, (234): 73-82.

Bauer, M.; Reusch, S.; Engels, T. and Wiesler, F. (2001). Remote sensing - a tool for site-specific N management in sugar beet production without impacts on technical beet quality. Plant nutrition: food security and sustainability of agro ecosystems through basic and appliead research. Fourteenth International Plant Nutrition Colloqium, Hannover, Germany, 338-339.

Bell, C.; Jones, J.; Franklin, J.; Milford, G. and Leigh.R. (1995). Sulphate supply and its effects on sap quality during growth in sugar beet storage roots. Zeitschrift fur pflanzenernahrung und Bodenkunde, 158(1): 93-95.

Black, C.A.; Erans, D.D.; Ensminger, L.E.; White, J.L. and dark, F.E. (1985). Methods of Analysis. Amer. Soc. of Agronomy, Inc. Madison, Wisconsin, U.S.A. Library of Congress Catalog Card Number, 65-15800 Seventh Printing.

Carruthers, A.A. and Old Field, J.F.T. (1961). Methods for assessment of beet quality. Int. Sug. J. 63. 72h, 103-105.

Carter, J.N. (1986). Potassium and sodium uptake by sugar beets as affected by nitrogen fertilization rate, location and year. J. Am. Soc. Sugar Beet Technol. 23: 121-141.

El-Dosouky, M.M. and Attia, K.K. (2004). Effect of mineral, organic and biofertilization on yield and quality of sugar beet plants. Assiut Journal of Agricultural Sciences, 35(3): 161-180.

El-Harriri, D.M. and Gobarh, E. (2001). Response of growth, yield and quality of sugar beet to nitrogen and potassium fertilizers under newly reclaimed soils. J. Agric. Sci., Mansoura Univ., 26(10): 5895-5907.

El-Maghraby, S.S.; Sam, M.M.S. and Tawfik, Y.H. (1998). Effect of soil and foliar application of nitrogen and potassium on sugar beet. Egyptian Journal of Agricultural Research, 76(2): 665-678.

Ewis, M.M. (2004). Effect of irrigation, potassium fertilization and crop rotation on production of sugar beet in Beni-Suef Governorate. Ph.D.Thesis, Fac. of Agric. Minia Univ. Egypt.

Ferweez, H. and El-Wafa, A.M.A. (2004). Enhancing productivity, quality and profitability of sugar beet (*Beta vulgaris* L.) using optimal level and addition time of potassium fertilizer under Middle Egypt conditions. Assiut Journal of Agricultural Sciences, 35(3): 107-127.

Hilde, D.J. Bass, S.; Levos, R.W. and Ellingson, R.L. (1983). Grower practices system promotes beet quality improvement in the Red River Vally. J. Am. Soc. Sugar Beet Technol. 9: 170-177.

Hoffmann, C.M. (2005). Changes in N composition of sugar beet varieties in response to increasing N supply. Journal of Agronomy and Crop Science, 191(2): 138-145.

Hsiao, T.C. and Lauchli, A. (1986). In: Advances in Poland Nutrition. Vol. 2. Eds. P.B. Tinker and A. Lauchli. pp. 281-312. Praeger, New York.

Ismail, A.M.A. and Abo El-Ghait, R.A.A. (2004). Effect of balanced fertilization of NPK on yield and quality of sugar beet. Egyptian Journal of Agricultural Research, 82(2): 717-729.

Jackson, M.L. (1973). Soil Chemical Analysis. Prentic Hall, New Delhi, India.

Le-Docte, A. (1927). Commercial determination of sugar in the beet root using the Sacks. Le-Docte process. Int. sugar J. 29: 488-492.

Milford, G.F.J.; Armstrong, M.J.; Jarvis, P.J.; Houghton, B.J.; Bellett Travers, D.M.; Jones, J. and Leigh, R.A. (2000). Effect of potassium fertilizer on the yield quality and potassium off take of sugar beet crops grown on soils of different potassium status. Journal of Agricultural Science, 135(1): 1-10.

Olsen, S.R.; Cole, C.V.; Watanable, F.S. and Dean, L.A. (1954). Estimation of available phosphorus in soil by extraction with sodium bicarbonate. U.S. Dept. Agric. Cir. 939: 19.

Orlovius, K. (1993). Sugar beet quality, the importance of potassium. Potash Review, Subject 7, 5 h suite, 2: 1-6.

Osman, M.S. (2005). Effect of potassium and magnesium on yield and quality of two sugar beet varieties. Egyptian Journal of Agricultural Research, 83(1): 215-228.

Piper, C.S. (1950). Soil and Plant Analysis. Inter Science Publisher, New York, 42-110.

Ramadan, B.S.H. (1997). Sugar beet yield and quality as affected by nitrogen and potassium fertilization. Pakistan Sugar Journal, 11(1): 8-13.

Snedecor, G.W. and Cochran, W.G. (1980). Statistical methods, 7th Edition. Iowa state Univ., Press, Ames IA.

Tsialtas, J.T. and Maslaris, N. (2005). Effect of fertilization rate on sugar yield and non-sugar impurities of sugar beets (*Beta vulgaris*) grown under Mediterranean conditions. Journal of Agricultural and crop Science, 191(5): 330-339.

Wyn, Jones, R. G. and Pollard, A. (1983). In Encyclopedia of plant physiology. New York. Vol. 15 B. Inorganic plant Nutrition. Eds. A. Lauchli and R.L. Bieleski. pp. 528-562. Springier Velag Berlin.

استجابة بنجر السكر لإضافة النتروجين والبوتاسيوم والصوديوم إلى الأراضى المستصلحة حديثا في محافظة المنيا

عطيه محمد طلب* - عبد الحفيظ يونس لاشين* - صفوت أحمد إسماعيل** - غادة فتح الله الشريف**

*قسم الأراضى - كلية الزراعة - جامعة المنيا

** معهد بحوث الأراضى والمياه والبيئة ــ مركز البحوث الزراعية بسدس

أقيمت تجربتان حقليتان في الأراضى الواقعة غرب مركز بنى مزار ممثلة للأراضى حديثة الاستصلاح بمحافظة المنيا لدراسة تأثير التسميد النيتروجينى (٠، ٧٠، ١٤٠ كجم ن/فدان) والبوتاسى (٠، ٤٨، ٩٦ كجم بو٢ أ/فدان) وإضافة الصوديوم (٠، ٧٥، ١٥٠ كجم ص/فدان) على المحصول، وخصائص جودته، وخواص العصير الناتج من بنجر السكر. واتبع في تنفيذ التجربة تصميم القطاعات الكاملة العشوائية فى أربع مكررات وكانت أهم نتائج الدراسة ما يلى:

أولاً: تأثير التسميد الآزوتى:

بزيادة التسميد النيتروجينى ازداد محصول الجذور الطازج ومحصول السكر ونسبة المواد الصلبة الكلية والأحماض الأمينية ومحتوى السكر في العصير، بينما نقصت نسبة السكروز ونسبه النقاوة ومحتوى الصوديوم في العصير بزيادة النيتروجين.

ثانياً: تأثير التسميد البوتاسى:

بزيادة التسميد البوتاسى ازداد محصول الجذور الطازج ومحصول السكر ونسبة المواد الصلبة الكلية ومحتوى البوتاسيوم في العصير، بينما نقصت نسبة السكروز ونسبة النقاوة والمحتوى الصوديومى في العصير بزيادة التسميد البوتاسى.

ثالثاً: تأثير إضافة الصوديوم:

ازداد كل من محصول الجذور الطازج للفدان وكذلك محصول السكر و نسبة المواد الصلبة الكلية والأحماض الأمينية ومحتوى الصوديوم في العصير بزيادة إضافة الصوديوم، بينما نقصت نسبة النقاوة ومحتوى البوتاسيوم في العصير بزيادة مع إضافة الصوديوم. ولم تتأثر نسبة السكروز بإضافة الصوديوم.

رابعاً: تأثير التداخل:

أثر التداخل بين التسميد البوتاسى وإضافة الصوديوم على إنتاجية محصول بنجر السكر، حيث أدت إضافة ٧٥ أو ١٥٠ كجم صوديوم للفدان إلى زيادة المحصول في حالة غياب البوتاسيوم، بينما في حالة وجود ٤٨ أو ٩٦ كجم بو٢ أ/فدان فإن المحصول لم يتأثر بإضافة الصوديوم. وهذا يشير إلى أنه يمكن لنبات بنجر السكر أن يستفيد من الصوديوم بدلاً من البوتاسيوم في حالة وجود الأخير بمعدلات منخفضة. وحسب النتائج المتحصل عليها يمكن التوصية تحت ظروف الأراضى الرملية الجديدة بمحافظة المنيا على أعلى إنتاجية بما يلي:

١- التسميد الأزوتى بمعدل ١٤٥ كجم ن للفدان + التسميد البوتاسى بمعدل ٩٨ بو٢ أ/فدان.

٢- أو إضافة ١٤٠ كجم نيتروجين/فدان + ٧٥ كجم صوديوم/فدان في حالة عدم توافر البوتاسيوم.