Sugar Beet Response to Nitrogen and Potassium Fertilization Treatments in Sandy Soil

M. A. Gomaa*, G. Abdel-Nasser, M. F. Maareg*** and M. M. El- Kholi ******
*Plant Production Department, Faculty of Agriculture (Saba- Basha). Alex. Univ.
**Soils and Agricultural Chemistry Department, Faculty of Agriculture (Saba- Basha). Alex. Univ.
*** Sugar Crops Research Institute, Agricultural Research Center
****Agriculture Machinery Sector, Agriculture Research Center.

ABSTRACT: Two field experimental were carried out at 71 Km West Nubaryia Cairo Desert Road El- Behara Gov. Egypt during two successive seasons 2014/ 15 and 2015/ 16 to study the effects of four nitrogen fertilizer rates (without, 33.5, 67 and 100.5 kg N/ fed.), four potassium fertilizer rates (without, 16, 32 and 48 kg k_2o/ fed.) and their interactions on yield and quality of multigerm sugarbeet cultivar (Magribl) grown in sandy soil under drip irrigation system were investigated at West Noubaryia region condition. In this split plot design, the main plots were assigned to rates of nitrogen fertilizer and potassium rates were arranged to random as the sub- plots. The results indicated that increasing nitrogen and potassium fertilizer rates significantly increased yield characterizes, roots, top and sugar yields (tons/ fed.). Adding the highest rates of nitrogen (100.5 kg N/ fed.) and potassium (48 kg K_2O/ fed.) produced the highest sugarbeet yields of roots (34.98 and 29.39 tons/ fed.), top (28.73 and 22.53 tons/ fed.) and sugar (4.76 and 3.82 tons/ fed.), respectively. Increasing nitrogen rate up to 100.5 kg N/ fed. and potassium rate up to 32 Kg K_2O/ fed. significantly, increased of some juice quality, total soluble solids (T.S.S) and sucrose concentration in roots juice. While the other juice trait, purity percentage was insignificant affected by nitrogen and potassium application rates. The maximum T.S.S% (21.37 and 20.43) and sucrose% (16.90 and 16.36) was achieved by adding 100.5 Kg N and 32 Kg K_2O/ fed., respectively. Also, increasing nitrogen and potassium fertilizer rates significantly increased impurity parameters, (Na, K, α- amino nitrogen percentages and loss sugar%) as well as decreased QZ%. In conclusion nitrogen fertilizer application at a rate of 100.5 kg N/ fed. accompanied with 48 kg K_2O/ fed. was found to be the most favorable for improving the yield and quality of sugarbeet grown in a sandy.

Key words: sugarbeet, yield characters, quality, Impurities parameters nitrogen, potassium fertilizer rate.

INTRODUCTION

The population of the world will exceed 9 billion by the year 2050. It is, therefore, of vital importance to improve crop yield to match the requirements for food. However, as the environment was becoming worse, the quantity and quality of crop production were significantly decreased by a variety of biotic and abiotic stresses. The practice of intensive fertilization to support massive food production for an increasing global population is a must. However, consumption of excess N fertilization and K deficiency cause a reduction in crop yields and quality in many regions. Therefore, to enable closing yield gaps and allow for a much higher productivity in many regions, a significant increase in fertilization application is required. K is an essential plant nutrient that impacts a number of physiological and biochemical processes that are involved in plant resistance to biotic and abiotic stresses. Maintaining an optimum K nutritional status is essential for plant resistance to biotic and abiotic stresses. Balanced fertilization and efficient K usage in combination with other nutrients not only contribute to sustainable crop's growth, yield and quality, but also influence plant health and reduce the environmental risks (Wang *et al.*, 2013).

In addition, Potassium (K) is one of the essential macronutrients for higher plants, not only important for plant growth and development, but also crucial for crop yield and quality (Wang and Wu, 2015). Nitrogen (N), one of the most important mineral nutrients in higher plants, is involved in plant metabolism as a constituent of amino acids, proteins, nucleic acids, lipids, chlorophyll, co-enzymes, phytohormones, and secondary metabolites (Wang *et al.,*. 2016). The application of too little nitrogen will result in reduced root tonnage, however, the application of too much nitrogen will result in reduced sugar concentrations and increased impurities (Hergert, 2010).

Now, Egypt faces many problems that affect the productivity of crops in general and sugar crops in particular, including sugar beet, which evolves significantly at the moment. So that, it became the first source for the production of sugar in Egypt, where the production of sugar from beets has 57% (1,347 Million tons) of sugar production in Egypt**.** While the sugar cane production was 43% (1,025Million tons), (Sugar Crops Council , 2016). One of the main problems is the water after building El- Nahda Dam and the high prices of fertilizer, particularly nitrogen and potassium.

Now, there is no accurate and wide-ranging information which considers to consequence of nitrogen and potassium fertilizer rates on yield and quality of sugar beet in sandy soil under drip irrigation system at West Noubaryia region conditions.

MATERIAL AND METHODS

Two field experiments were conducted at km 71 West Noubaryia, Alex. Cairo desert Road, El Behiera governorate, Egypt during two successive seasons, 2014/ 15 and 2015/ 16, to study the effect of nitrogen and potassium fertilizer rates and their interactions on yield characters, quality and impurity parameters of multigerm sugar beet (*Beta vulgaris* L.) cv. Magribl. The nitrogen and potassium fertilizers were in the forms of urea (46 %N) and potassium sulphate (48 % K_2O), respectively, were applied as a side- dressing in two equal doses. The first was applied after thinning and the other was applied four weeks later.

- The nitrogen rates used

Without nitrogen fertilizer (N_0), 33.5 kg N/ fed. (N_1), 67 kg N/ fed.(N_2) and 100.5 kg N/ fed.(N_3)

- Potassium rates used

Without potassium fertilizer (K_0), 16 kg K_2O/ fed.(K_1), 32 kg K_2O/ fed.(K_2) and 48 kg K_2O/ fed.(K_3)

Before soil preparation, soil samples were taken at a depth of 0: 30 cm depth from different experimental sites, to determine physical and chemical properties of soil according to Piper (1950) as shown in Table (1).

Table (1). Some physical and chemical properties of the experimental soil in 2014/2015 and 2015/2016 seasons

Soil properties	2014/2015	2015/2016
A- Mechanical analysis		
Sand%	88.85	88.23
Clay%	4.30	4.80
Silt%	6.85	6.97
Soil texture	Sandy	Sandy
B- Chemical properties		
pH (1:1)	8.50	7.35
EC (dS/m) (soil : water extract)	1.20	1.14
1- Soluble cations (1:2) (meq/L))		
K^+	0.82	1.20
Ca^{++}	2.76	3.10
Mg^{++}	1.90	2.30
Na^+	4.35	4.65
2- Soluble anions (1:2) (meq/L)		
HCO^-_3	2.72	2.72
CL^-	7.90	7.09
$SO^=_4$	1.15	0.98
Calcium carbonate (%)	20.0	20.0
Available nitrogen (mg/kg)	33.00	23.00
Available Potassium (mg/kg)	115.20	112.75
Organic matter (%)	0.37	0.83

Each field experiment was including two factors in split- plot design with three replications. The main plots were assigned to rates of nitrogen fertilizer and potassium rates Z6 meters in length, thus, the area of the plot was 21 m^2 (6 x 3.5 m) 1/200 fed.

The experimental field well prepared through two ploughing, leveling, compaction, ridging, and then divided into the experimental units. Calcium super phosphate (15.5 % P_2O_5) was applied during soil preparation at the rate of 100 kg/ fed. Sugar beet balls were hand sown 3- 5 balls/ hill using dry sowing method on one side of the ridge in hills 20 cm apart on 13^{ts}october during two seasons. The plots were irrigated immediately after sowing directly. Plants were thinned at the age of 4 leaf stage to obtain one plant/ hill. The common agricultural practices for growing sugar beet according to the recommendations of Ministry of Agriculture were followed, except the factors under study.

Data Recorded:

The outer two ridges (1^{st} and 6^{th}) were considered as a belt, while plants of the 2^{nd}, 3^{rd}, 4^{th} and 5^{th} were kept for determination of yield characters and technological qualities.

I- Yield characters

At harvest, plants that produced from the four ridges (from 2 to 5) of each sub sub-plot were collected. Roots and tops were separated and weighted in kilograms, then converted to estimate:

1. Roots yield (tons/fed)
2. Top yield. (tons/fed)
3. Sugar yield (tons/fed)

It was calculated by multiplying roots yield × sucrose percentage

II- Juice Quality

Total soluble solids percentage (TSS %) in roots.

It was measured in juice of fresh roots by using Hand Refractmeter (Me Ginnis 1982).

1. Sucrose percentage.
2. Purity percentage.

III- Impurities parameters:

1. Sodium (Na ; meq/100 g)
2. Potassium (K; meq/100 g)
3. α- amino nitrogen (α- AN; meq/100 g)
4. Extractable white sugar % (ZB%).

Correct sugar content (white sugar) of beet was calculated by linking the beet non K, Na and α-amino Nitrogen expressed a (meq/100 g) according to Reinfeld *et al*. (1974) as described by Harvey and Dutton (1993) as follows

$$ZB = (Pol- 0.29) - 0.343 (K + Na) - 0.094 \ \alpha\text{-amino-N}$$

5. <u>Quality% (QZ%)</u>

   $QZ = (ZB \times 100) / (\alpha\text{-amino-N})$

6. <u>Alkalinity Coefficient (AK)</u>

   was determined as described by Harvey and Dutton (1993) as follows:

   $AK = (K + Na) / (\alpha\text{-amino-N})$

7. <u>Loss Sugar %</u>

   Loss Sugar % = Gross sugar % - White sugar%

   Gross sugar % = Sucrose%

   White sugar% = Extractable white sugar% (ZB%)

Sucrose, quality, purity and impurity parameters were determined in Sugar Nile Company.

Statistical analysis:

All data were statistically analyzed according to combine of two seasons by "MSTAT" Computer software package and least significant difference (LSD) method was used to test the differences between treatment means at 5% levels of probability.

RESULTS AND DISCUSSION

The effects of different nitrogen, potassium fertilizer rates and their interactions on sugarbeet yield characters, quality and impurity parameters in sandy soil field under drip irrigation system are illustrated in Tables (2 to 5).

I- Yield characters:

Data of the effects of different nitrogen, potassium fertilization rates and their interactions on sugarbeet yield characters i.e. roots yield, top yield and sugar yield were recorded in Table (2).

I-1- Roots yield (tons / fed.)

The result in Table (2) cleared that the roots yield (tons/fed.) was significantly increasing with increasing nitrogen rate from N_0 [without] to N_1 (33.5), N_2 (67.0), and N_3 (100.5) kg N/ fed. Application nitrogen at the higher rate (100.5kg N/ fed.) produced the highest roots yield (34.98 tons/ fed.), while, the lowest one (19.70 tons/ fed.), resulted from control treatment (without nitrogen fertilizer). The increasing than control treatment (N_0) for N_1, N_2, N_3 rates were 24.18, 41.15 and 77.55 %, respectively. Such effect might have due to improved beet growth in term of more dry matter accumulation.

Also, the results in Table (2) showed that increasing potassium fertilizer rate from K_0 [without] to K_1 (16 kg K_2O/ fed.), K_2 (32 kg K_2O/ fed.), and K_3 (48 kg K_2O/ fed.) rates significantly increased roots yield by 15.65, 20.41 and 27.31 %, respectively as compared with the control treatment (K_0). The highest yield (29.39 tons/ fed.) resulting from potassium fertilizer at K_3 rate. Roots yield /fed. Significantly effected by the interaction between nitrogen and potassium fertilizers revealed that the combination of $N_3 + K_3$ (100.5 kg N/ fed. + 48 kg K_2O / fed.) had the highest roots yield (40.75 tons/fed.)

I-2- Top yield (tons/ fed.)

The data in Table (2) indicated that top yield (tons/ fed.) significantly increased as a results of increasing nitrogen fertilizer rates. Roots yields resulting from nitrogen fertilizer were 12.35, 17.24, 21.83 and 28.73 tons/ fed. at the rates of 33.5, 67 and 100.5 kg N/ fed., respectively . Relative percentages of increase in top yield to control treatment were 39.55, 76.73 and 132.62 % for N_1, N_2 and N_3 rates, respectively.

According to potassium fertilizer rates, increasing potassium fertilizer rate from K_0 (without fertilizer) to K_1, K_2 and K_3 significantly increased top yield. No significant difference was found between applied K_2 and K_3 rates in this respect. Fertilizing sugarbeet plants with K_0, K_1, K_2 and K_3 rates produced 17.04, 19.18, 21.41, and 22.53 tons/ fed. of top yield, respectively. The increase percentage in top yield as compared with control treatment were 12.60, 25.61, and 32.27 for K_1, K_2 and K_3 rates, respectively. There were significant effects for the interaction between nitrogen and potassium fertilization rates on top yield/ fed. The highest top yield values (30.50 and 31.48 tons/ fed.) was obtained by planting beets with combination of $N_3 + K_2$ (100.5 Kg N/ fed. + 36 kg K_2O/ fed.) or $N_3 + K_3$ (100.5 kg N/ fed. + 48 kg K_2O/ fed.) Table (2).

Table (2). Effect of different nitrogen, potassium fertilizer rates and their interactions on yield characters of sugarbeet crop in combine analysis of 2014/15 and 2015/16 seasons.

Nitrogen rates (N)	Potassium (K) rates K_0	K_1	K_2	K_3	Average	Increase%
Root yield (tons/fed.)						
N_0	17.57	20.77	20.15	20.32	19.70	
N_1	20.66	24.02	27.40	25.79	24.46	24.18
N_2	24.65	27.57	28.34	30.69	27.81	41.15
N_3	29.45	34.43	35.30	40.75	34.98	77.55
Average	23.08	26.69	27.79	29.39		
Increase%		15.65	20.41	27.31		
Top yield (tons/fed.)						
N_0	9.56	11.73	13.77	14.36	12.35	
N_1	13.94	15.30	19.92	19.80	17.24	39.55
N_2	18.83	22.13	21.86	24.50	21.83	76.73
N_3	25.82	27.58	30.05	31.48	28.73	132.62
Average	17.04	19.18	21.40	22.53		
Increase%		12.60	25.61	32.27		
Sugar yield (tons/fed.)						
N_0	2.01	2.42	2.52	2.57	2.38	
N_1	2.61	3.00	3.65	3.28	3.13	31.71
N_2	3.18	3.61	3.63	4.05	3.62	52.12
N_3	3.94	4.71	5.01	5.38	4.76	100.00
Average	2.94	3.44	3.70	3.82		
Increase%		17.08	26.18	30.08		

	Root yield	Top yield	Sugar yield
$LSD_{0.05}$ N	1.05	1.11	0.23
$LSD_{0.05}$ K	1.21	1.38	0.30
$LSD_{0.05}$ N×K	2.18	2.29	ns

In% = increase% than control treatment ns=not significant

I-3- Sugar yield:

Significant difference was noticed in sugar yield among nitrogen fertilizer rates. The highest sugar yield (4.76 tons/ fed.) value was produce from the highest rate of nitrogen fertilizer of 100.5 kg N/fed. followed by 67 N/fed (3.62 tons/ fed.), 33.5 N/fed (3.13 tons/ fed.) and control treatment (2.38 tons/ fed.) rates.

Therefore, the nitrogen had the greatest direct effect on sugar yield value .The relative increases than control treatment were 31.71, 52.12 and 100% for 33.5, 67.0 and 100.5 kg N/ fed. rates, respectively as shown in Table (2). Comparing among potassium fertilizer rates, increasing rate of potassium fertilization enhanced sugar yield/ fed. The rates of K_2 (3.73 tons/ fed.) and K_3 (3.82 tons/ fed.) significantly increased sugar yield /fed. than both K_0 (2.14 tons/ fed.) and K_1 (3.44 tons/ fed.) rates, without significant differences between them. Relative increases than control treatment for K_1, K_2 and K_3 potassium rates were 17.08, 26.18 and 30.8 %, respectively. There was not significant effected for interaction between nitrogen and potassium rates on sugar yield.

The data in Table (2) showed that increasing nitrogen significantly increased roots yield, top yield, and sugar yield. The same results had been observed throughout different experiments which were obtained by Agami (2005); Maareg *et al.* (2005 a & b); Leilah *et al.*(2005); Ouda (2007); Osman (2011); Sarhan (2012); Shaban *et al*. (2014); Abdelaal and Tawfik (2015) and El–Deeb (2016). Also, Table (2) cleared that increasing nitrogen rate significantly increased yield characters i.e. roots, top and sugar yields. These results are in agree with those of Abido *et al*. (2015).

The data observed that roots and top yield significantly affected in the interaction between nitrogen and potassium fertilization rates. On the contrary, sugar yield/ fed. insignificantly affected by the interaction between nitrogen and potassium rates. These results are in agreement those of Osman (2005) and El-Shafai (2000).

II- Juice Quality:

The effects of nitrogen and potassium fertilizer treatments on sugarbeet juice quality i.e. total soluble solids (T.S.S%), sucrose and purity percentages were tabulated in Table (3)

II-1-Total soluble solids percentage (T.S.S%):

Significant difference was noticed for T.S.S % value among nitrogen rates. The highest T.S.S % value was resulted by adding higher nitrogen rate (100.5 kg N/ fed.) followed by 67 and 33.5kg N/ fed. rates, with an average of 21.37, 20.17, 19.84 and 18.5%, respectively. The relative increase than control treatment (without nitrogen fertilizer) were 7.25, 9.06, and 15.52% for N_1 (33.5), N_2 (67.0), and N_3 (100.5) kg N/ fed. respectively (Table, 3). Comparing among potassium rates, increasing potassium rate enhanced T.S.S %. The rate of K_2 (20.43) and K_3 (20.40) significantly increasing T.S.S % than both K_0 (19.36 %) and K_1 (19.67 %) rate, without significant difference between them. Relative increase than K_0 rate for K_1, K_2 and K_3 rates were 1.59, 5.53, and 5.38 %, respectively (Table 3).

II-2-Sucrose percentage:

The data in Table (3) showed that increasing nitrogen rates from N_0 (14.94%) to N_1 (15.87%), N_2 (16.16%) and N_3 (17.04%) increased sucrose% by 6.22, 8.21 and 14.08%, respectively. These differences were significant values. Also, the data showed that the highest sucrose % values were recorded by applying K_2 (16.36%) and K_3 (16.25%) potassium fertilizer rates, without significant differences between them. These two potassium rates significantly increased sucrose% than K_0 and K_1 rates (Table 3)

II-3- Purity percentage:

The tested different rates of nitrogen, potassium fertilizer and their interactions on purity% were no significant differences.

III- Impurity Parameters:

Data of the effects of nitrogen, potassium fertilizer rates and their interactions on sugarbeet impurity parameters (Na, K, α- amino nitrogen percentages, Extractable white sugar% (ZB%), Quality% (QZ %), Alkalinity Coefficient (AK) and loss sugar%) were recorded in (Tables 4 and 5).

Table (3).Effect of different nitrogen, potassium fertilizer rates and their interactions on TSS%, Sucrose% and purity% of sugarbeet crop in combine analysis of 2014/15 and 2015/16 seasons.

Nitrogen rates (N)	Potassium (K) Rates					Inc% or dec%
	K_0	K_1	K_2	K_3	Average	
Total Soluble Solids %						
N_0	17.25	17.98	19.27	19.48	18.50	
N_1	19.45	19.50	20.33	20.07	19.84	7.25
N_2	19.97	20.30	20.02	20.40	20.17	9.06
N_3	20.78	20.90	22.12	21.67	21.37	15.52
Average	19.36	19.67	20.43	20.40		
Increase%		1.59	5.53	5.38		
Sucrose%						
N_0	14.05	14.47	15.53	15.70	14.94	
N_1	15.70	15.57	16.18	16.02	15.87	6.22
N_2	15.93	16.33	16.01	16.39	16.16	8.21
N_3	16.75	16.79	17.73	16.90	17.04	14.08
Average	15.61	15.79	16.36	16.25		
Increase%		1.16	4.83	4.12		
Purity%						
N_0	81.48	80.47	80.60	80.57	80.78	
N_1	80.73	79.85	79.61	79.83	80.00	-0.96
N_2	79.84	80.46	80.10	80.33	80.18	-0.74
N_3	80.61	80.30	80.17	78.03	79.78	-1.24
Average	80.67	80.27	80.12	79.69		
Decrease%		-0.49	-0.68	-1.21		

	Total Soluble Solids%	Sucrose%	Purity%
$LSD_{0.05}$ N	0.61	0.44	ns
$LSD_{0.05}$ K	0.52	0.41	ns
$LSD_{0.05}$ N×K	ns	ns	ns

Inc% (increase%) or dec% (decrease) than control treatment ns=not significant

III-1- Sodium (Na meq/100g)

The data in Table (4) observed that increase nitrogen rates from N_0 to N_1, N_2 and N_3 rates significantly increased Na% by 21.05, 41.65 and 79.06%, respectively. Also, there were positive correlation between potassium rates and Na%. The ascending sequences of tested potassium rates were as follows: K_0 (1.43 meq/100 g) < K_1 (1.60 meq/100 g) < K_2 (1.66 meq/100 g) < K_3 (1.83 meq/100 g). The last rate (the higher rate) of potassium increased Na % by 79.06% in compared with K_0 rate (without potassium fertilizer) or control treatment, as show in Table (4).

III-2- Potassium (Ka meq/100g)

The data in Table (4) also showed that increasing nitrogen fertilizer rates from N_0 to N_3 kg N/ fed. significantly increased potassium percentage from 6.66 to 11.67 (meq/100 g) in roots juice.

Table (4). Effect of different nitrogen, potassium fertilizer rates and their interaction on impurity parameters of sugarbeet crop in combine analysis of 2014/15 and 2015/16 seasons.

Nitrogen rates (N)	Potassium (K) Rates					Increase%
	K_0	K_1	K_2	K_3	Average	
			Na (meq/100 g)			
N_0	1.13	1.29	1.19	1.21	1.20	
N_1	1.27	1.49	1.51	1.55	1.46	21.05
N_2	1.51	1.56	1.74	2.01	1.70	41.65
N_3	1.83	2.04	2.18	2.57	2.16	79.06
Average	1.43	1.60	1.66	1.83		
Increase%		11.28	15.46	27.90		
			K (meq/100 g)			
N_0	6.09	7.13	6.68	6.73	6.66	
N_1	6.93	7.90	8.49	8.26	7.89	18.54
N_2	8.00	8.78	9.35	10.50	9.16	37.47
N_3	9.70	11.52	12.07	13.39	11.67	75.20
Average	7.68	8.83	9.15	9.72		
Increase%		14.97	19.08	26.57		
			A-amino N (meq/100 g)			
N_0	3.14	3.67	3.54	3.46	3.45	
N_1	3.27	3.58	4.52	3.83	3.80	10.01
N_2	3.82	4.34	4.69	5.00	4.46	29.31
N_3	4.56	5.89	5.83	6.12	5.60	62.17
Average	3.70	4.37	4.65	4.60		
Increase%		18.26	25.67	24.50		

	Na	K	A-amino N
LSD $_{0.05}$ N	0.212	1.172	0.248
LSD $_{0.05}$ K	0.075	0.511	0.114
LSD $_{0.05}$ NK	0.170	1.15	0.256

Increase% = increase% than control treatment

The relative increases in K% than control treatment (N_0) were 18.54, 37.47 and 75.20% for N_1, N_2 and N_3 rates, respectively. Potassium concentration in roots juice significantly increased with increasing potassium fertilizer rates. K% values could be arranged in the following descending order according to potassium rates: K_3 (9.72 meq/100 g), K_2 (9.15 meq/100 g), K_1 (8.83 meq/100 g) and K_0 (7.68 meq/100 g), without significant differences between applied K_1 and K_2 potassium rates. The increases in potassium% were 14.97, 19.08 and 26.57% than control treatment for K_1, K_2 and K_3, respectively.

III-3- Alpha – amino nitrogen (α- AN meq/100g)

Raising nitrogen fertilizer rate from N_0 (without nitrogen fertilizer) to N_1, N_2 and N_3 rates significantly increased α- AN in root juice from 3.45 to 3.80, 4.46 and 5.60 meq/100 g respectively. These increases than control treatment were 10.01, 29.31 and 62.17 % for N_1 , N_2 and N_3 rates , respectively (Table 4).

Regarding to the effects of potassium fertilizer rates, K_2 (4.65 meq/100 g) and K_3 (4.60 meq/100 g) rates significantly increased α- AN than K_1 (4.37 meq/100 g) and K_0 (3.70 meq/100 g). However, there was no significant difference between the first mentioned potassium rates and vice versa between the last ones as shown in (Table 4).

The results in (Table 5) illustrated that all tested impurity parameters not significantly affected by interaction between nitrogen and potassium rates. The results inducted that increasing nitrogen fertilizer rate significantly increased the impurity characters, these results are similar to those achieved by Osman *et al* (2010); Abd El- Kader (2011); Ferweez *et al* (2011) and Mekdad (2015). In contrast, Tawfik, Sahar (2000) found that the effect of nitrogen fertilizer rates from 30 to 120 kg N/fed. had insignificants effects on these juice impurities. Also the results observed that increasing potassium fertilization rate significantly increased Na, K, α- amino nitrogen in juice roots .The results are in agreement those obtained by Abo El-Ghait (2013) and Abdou (2014).

It could be concluded that 100.5 Kg N/ fed. accompanied with 48 Kg K_2O/ fed. gave the optimum and improving the yield and quality of sugarbeet grown in sandy soil.

III-4- Extractable white sugar% (ZB%)

Table (5) revealed effect of different nitrogen, potassium fertilizer rates and their interactions on Extractable white sugar% (ZB%), Quality% (QZ%), Alkalinity Coefficient (AK) and Loss Sugar % of sugarbeet crop.

The effect of N levels on ZB% was neglect, where the relative increases than N_0 was not more than 1.73%, therefore there were no significant differences among N levels. In regards to K levels, the highest effective level was K_1 (12.17%) followed by K_0 (11.86%) without significant differences.

Also, K_3 (11.61%) gave the higher ZB% than K_2 (11.55%) without significant differences. The relative increase than $K_1$was 2.61 % for K_2 and its relative decrease was 2.66 % and 2.17% at K_1 and K_3, respectively. The lowest effective K level was K_2. Thus, the effect of K levels gave varied responses without exact direction. In conclusion, only K levels had effects on ZB%.

III-5- Quality% (QZ %)

Both N and K levels harbored significantly effects on QZ% (Table 5). Increasing both N and K levels decreased QZ%. Consequently, the highest effective N and K levels were N_0 (80.55%) and K_0 (76.45%). On contrary, the lowest ones were N_3 (69.96%) and K_3 (71.51%). The relative decrease for previous levels than N_0 and K_0 were 13.14% and 6.46%, respectively. In regards to the interaction between N and K levels, the highest and the lowest values of QZ% were N_0K_0 (83.01%) and N_3K_3 (64.15%). The effect of N levels had more effects than K ones.

III-6- Alkalinity Coefficient (AK)

The efficacy of N and K levels on AK was presented in Table (5). The effects of N and K levels gave variant responses. The highest effective N and K levels were N_2 (2.43) and K_0 (2.39), respectively.

Table (5). Effect of different nitrogen, potassium fertilizer rates and their interactions on Extractable white sugar% (ZB%), Quality% (QZ%), Alkalinity Coefficient (AK) and Loss Sugar % of sugarbeet crop in combine analysis of 2014/15 and 2015/16 seasons.

Nitrogen rates (N)	Potassium (K) Rates					Inc% or dec%
	K_0	K_1	K_2	K_3	Average	
ZB %						
N_0	11.96	11.98	11.64	11.60	11.80	
N_1	11.67	12.46	11.36	11.78	11.81	0.16
N_2	11.39	11.82	11.47	11.64	11.58	-1.84
N_3	12.43	12.43	11.73	11.41	12.00	1.73
Average	11.86	12.17	11.55	11.61		
Inc% or dec%		2.61	-2.66	-2.17		
QZ %						
N_0	83.01	81.76	79.55	77.86	80.55	
N_1	76.33	77.25	71.94	72.98	74.62	-7.35
N_2	71.74	72.38	69.67	71.05	71.21	-11.59
N_3	74.73	72.88	68.07	64.15	69.96	-13.14
Average	76.45	76.07	72.31	71.51		
Inc% or dec%		-0.50	-5.42	-6.46		
AK(meq/100 g)						
N_0	2.42	2.23	2.22	2.31	2.29	
N_1	2.37	2.39	2.25	2.32	2.33	1.73
N_2	2.47	2.44	2.36	2.46	2.43	5.99
N_3	2.27	2.40	2.36	2.44	2.37	3.23
Average	2.39	2.36	2.30	2.38		
Inc% or dec%		-0.87	-3.59	-0.21		
Loss sugar%						
N_0	2.44	2.68	3.00	3.30	2.85	
N_1	3.62	3.65	4.44	4.37	4.02	40.88
N_2	4.49	4.53	4.99	4.72	4.68	64.21
N_3	4.21	4.64	5.47	6.41	5.18	81.69
Average	3.69	3.88	4.47	4.70		
Increase%		5.08	21.27	27.39		

	ZB%	QZ%	AK	Loss sugar%
LSD $_{0.05}$ N	ns	2.613	ns	0.472
LSD $_{0.05}$ K	0.402	1.296	ns	0.192
LSD $_{0.05}$ N×K	ns	2.92	ns	0.432

Inc% (increase%) or dec% (decrease) than control treatment ns=not significant

In addition, the lowest values for both previous factors were N_0 (2.29) and K_2 (2.30), respectively. Although these variations, there were no significant differences among both tested factors.

III-7- Loss Sugar %

Table (5) illustrated that the tested factors significantly effected on loss sugar%. N levels could be arranged in the following descending order according to Loss sugar%: N_3 (5.18%) > N2 (4.68%) > N1 (4.02%) > N0 (2.85%). The relative increase than N_0 for N_3, N_2 and N_1 levels were 81.69, 64.21 and 40.88%, respectively.

K levels indicated that the highest loss sugar% was recorded at K_3 (4.70%) followed by K_2 (4.47%), K_1 (3.88%) and the least one was K_0 (3.69%). However, the respective relative increases than K0 were 27.39, 21.27 and 5.08%.

The interaction between N and K levels was significant. The highest and lowest loss sugar% were observed at N_3K_3 (6.41%) and $N_0 K_0$ (2.44%).

Generally, increasing both N and K levels enhanced loss sugar%. Moreover, the N levels had superior effects on loss sugar% than K levels.

In generall, the quality parameters, T.S.S%, sucrose%, purity%, ZB% and AK insignificantly affected by the interaction between nitrogen and potassium rates. The present results showed that increasing nitrogen or potassium fertilizer rates significantly increased T.S.S%, sucrose% and loss sugar%, as well as decreased QZ%. Similar results were reported by Ramadan and Nassar (2004); Ismail and Abo El-Ghait (2005); Maareg *et al.* (2005 a& b); Ouda, (2007), Osman *et al.* (2010); Sarhan (2012); Abdou (2013), and Mekdad (2015). There was not effect for nitrogen or potassium fertilizer on purity% and AK, these results are in line with the findings of Abo El-Ghait and Mohamed, (2005) and Abdelaal and Tawfik (2015).

REFERENCES

Abdelaal, Kh. A. A. and Sahar, F. Tawfik (2015). Response of Sugar Beet Plant (*Beta vulgaris* L.) to Mineral Nitrogen Fertilization and Bio-Fertilizers. Current Microbi. and Appl. Sci. ,4 (9) : 677- 688.

Abd El-Kader, E. M. A. (2011). Effect of nitrogen fertilizer and some growth regulators treatments on sugar beet.J. Plant Production, Mansoura Univ., 2 (12): 1693 - 1702, 2011.

Abdou, M.A.E. (2013). Effect of nitrogen fertilization and harvesting dates on sugar beet productivity and quality in newly reclaimed sandy soils**.** J. Plant Production, Mansoura Univ., 4 (12): 1871 – 1882

Abdou, M. A.E. (2014). Response of sugar beet (*Beta vulgaris* L) productivity to potassium fertilization. Zagazig J. Agric. Res., 41(5): 961-968.

Abido, W.A.E., M.M Ibrahim and Maha M. El-Zeny (2015). Growth, productivity and quality of sugar beet as affected by antioxidants foliar application and potassium fertilizer top dressing. J. Asian Crop ,7(2):113-127

Abo Al-Ghait (2013). Effect of planting density, phosphorus and potassium fertilization on yield and quality of sugar beet.Menufiya J. Agric. Res. ,38(2): 273-283

Abo El-Ghait, R. A. and Samia G. A. Mohamed (2005). Agronomical and statistical studies on the response of some sugar beet varieties to nitrogen application. Minufiya J. Agric. Res. 30 (6): 1805-1821.

Agami, K.M. (2005). Effect of planting date, plowing depth and nitrogen fertilizer on yield and quality of sugar beet at Noubaria. Ph.D. Thesis, Fac. Agric., Moshtohor, Zagazig Univ.

El-Deeb, Hanan H. A.(2016). Effect of spraying amino acids to rationalize the use of nitrogen chemical fertilizers and its effect on the productivity of sugar beet yield in the salt-affected soils. M.Sc. thesis, Ain Shams Univ. Inst. Env. Studies and Research. Department of Environmental Agricultural Sciences.

EL-Shafai, A.M.A. (2000). Effect of nitrogen and potassium fertilization on yield and quality of sugar beet in Sohag. Egypt. J. Agric. Res., 78(2): 759-767

Harvey, C. W. and J.V. Dutton (1993). Root quality and processing. Pp 571-617. In "The sugar beet crop: Science into practice . Edited by DA Cook and scat. Published 1993 by Chapman & Hall, ISBN, 0412-25132

Ferweez, H., M.F.M. Ibrahim and A.M. Allani (2011). Improving yield and quality of sugar beet using boron at different levels of nitrogen fertilizer**.**Alex. Sci. Exch..32(1): 51-57

Hergert ,G. W. (2010). Sugar Beet Fertilization Published in Sugar Tech: An International Journal of Sugar Crops and Related Industries ,12(3-4). 256-266

Ismail, A.M. and R.A. Abo El-Ghait (2005). Effect of nitrogen sources and **rate**s on yield and quality of sugar beet.Egypt. J. Agric. Res. ,83 (1): 229-240

Leilah, A.A., M.A. Badawi, E. M. Said, M.H. Ghonema and M.A. E. Abdou (2005). Effect of Planting Dates, Plant Population and Nitrogen Fertilization on Sugar Beet Productivity Under the Newly Reclaimed Sandy Soils in Egypt. Scientific Journal of King Faisal University (Basic and Applied Sciences), 6 (1):95-110

Maareg, M.F; Twafik, S.F.; and I. M. A. Gohar (2005a). Effect of split and amount application of nitrogen fertilizer to sugarbeet on root-knot nematode, *Meloidogyne javanica* and crop production under sprinkler irrigation in sandy soil .The Third International Conference on IPM Role in Integrated Crop management and Impacts on Environment and Agricultural Products. 26-29 November 2005, Giza, Egypt. (published in Egypt. J. Agric. Res. 83 (2): 687-706)

Maareg, M.F; Twafik, S.F.; and A. A. Abo El Ftooh (2005b). Effect of Preceding Crops and Nitrogen Fertilization on Productivity of Sugarbeet and Some Economic Insect Pests Infestation in Newly Reclaimed Soil at West Nubaryia Region The Third International Conference on IPM Role in Integrated Crop management and Impacts on Environment and Agricultural Products. 26-29 November 2005, Giza, Egypt. (published in Egypt. J. Agric. Res. ,83 (2): 741-757)

Me Ginnis, R.A. (1982). Beet sugar technology.3rd ed. Sugar beet development foundation Fort Collins 855 pp)

Mekdad, A.A.A. (2015). Sugar Beet Productivity As Affected By Nitrogen Fertilizer and Foliar Spraying With Boron. International Journal of Current Microbiology and Applied

Osman, A.M.H, (2005). Influence of nitrogen and potassium fertilization on yield and quality of two sugar beet varieties. Egypt. J. Agric. Res., 83: 1237-1254

Osman, A. M. H.(2011). Influence of foliar spray of some micronutrients and nitrogen on productivity of sugar beet under newly reclaimed soils. J. Plant Production, Mansoura Univ., 2 (9): 1113 – 1122

Osman, M.S., A. M. Okaz, M.A. Soliman, Hasna A. Hosny and Maha F. El_Enany (2010). Response of sugar beet to nitrogen fertilizer and sulphar spray frequency in Middle Egypt. **Egypt. J. Agric. Res. , 83 (3)**: 1237-1254

Ouda, Sohier M.M. (2007). Effect of chemical and biofertilizer of nitrogen and boron on yield and quality of sugarbeet Zagazig J. Agric. Res., 34(1): 1-11

Piper, C. S. (1950). Soil and plant analysis. The Univ. of Adelaide, Australia

Ramadan, B. S. H. and A. M. Nassar (2004). Effect of nitrogen fertilization on yield and quality of some sugar beet varieties. Egypt. J. Agric. Res. ,82 (3): 1253-1268

Reinefeld, E., Emmerich, A., Baumgarten, G., Winner, C. and Beiss, U. (1974). Zur Voraussage des Melassezuckers aus Riibenanalysen. *Zucker,* 27, 2-15.

Sarhan, H.M. (2012). Effect of bio- and mineral fertilization on yield and quality of sugar beet. Journal of Plant Production, Mansoura University,11(3): 2513-2524

Shaban, KH.A. H.; Eman M. Abdel Fatah and Dalia A. Syed (2014). Impact of Humic acid and mineral Nitrogen fertilization on soil chemical Properties and yield and Quality of Sugar beet under Saline Siol. J.Soil Sci. and Agric. Eng., Mansoura Univ. ,5 (10): 1335 - 1353

Sugar Crops Council (2016). Annual report "Sugar crops and sugar production in Egypt in 2014/13 growing and juice 2015 season".108 pp

Tawfik, Sahar F. (2000). Effect of dates and sources of nitrogen fertilization on yield and quality of sugarbeet under surface and spray irrigation methods in newly reclaimed areas. Ph. D. Thesis, Faculty of Agriculture (Saba-Bash), Alexandria University. 311 pp

Wang, M, Q. Zheng, Q. Shen and S. Guo (2013). The Critical Role of Potassium in Plant Stress Response Int. J. Mol. Sci,14, 7370-7390

Wang, Y. and W. Wu (2015). Genetic approaches for improvement of the crop potassium acquisition and utilization efficiency. Current Opinion in Plant Biology, 25:46–52

Wang ,M. , L. Ding , L. Gao , Y. Li , Q. Shen and S. Guo (2016). The Interactions of Aquaporins and Mineral Nutrients in Higher Plants. Int. J. Mol. Sci., 17: 1229

Watson, D. J. (1958). The dependence of net assimilation rate on leaf area index. Ann. Bot., NS 22; 37-54.

الملخص العربي

إستجابة بنجر السكر لمعاملات التسميد النتروجينى والبوتاسى فى الأرض الرملية

محمود عبد العزيز جمعة [١]، جمال عبدالناصر خليل[٢]، محمد فتحى معـارج[٣] ، مصطفى مرسى الخولى[٤]

[١]قسم الانتاج النباتى – كلية الزارعة– سابا باشا – جامعةالاسكندرية

[٢]قسم الاراضي والكيمياء الزراعية – كلية الزارعة– سابا باشا – جامعةالاسكندرية

[٣]معهد المحاصيل السكرية– مركز البحوث الزراعية – الجيزة – مصر

[٤]قطاع الزراعة الالية – وزارة الزراعة – مركز البحوث الزراعية

أجريت تجربتان حقليتان خلال موسمى٢٠١٤/ ٢٠١٥ و ٢٠١٥/ ٢٠١٦ عند الكليو ٧١ طريق اسكندرية – القاهرة الصحراوى (منطقة غرب النوبارية) لدراسة تأثير أربعة معدلات من السماد النتروجينى" يوريا ٤٦% نتروجين (بدون إضافة ، ٣٣.٥ ، ٦٧ ، ١٠٠.٥ كجم نتروجين/ فدان) وأربعة معدلات من التسميد البوتاسى " سلفات البوتاسيم بو٢أ ٤٨% "" (بدون إضافة ، ١٦ ، ٣٢ ، ٤٨ كجم بو٢أ / فدان) والتداخل أو التفاعل بينهما على إنتاجية وجودة بنجر السكر صنف (ماجريبل) عديد الأجنة المنزرع فى الأرض الرملية بمنطقة غرب النوبارية – محافظة البحيرة. إستخدم فى هذة الدراسة تصميم القطع المنشقة مرة واحدة، ووضعت معدلات السماد النتروجينى فى القطع الرئيسية ووزعت معدلات السماد البوتاسى فى القطع الشقية عشوائيا،

وأوضحت النتائج الاتية

– يزداد محصول الجذور و محصول العرش ومحصول السكر زيادة جوهرية كنتيجة للزيادة فى المعدلات المضافه لكل من السماد النتروجينى والسماد البوتاسى، ووجد أن إضافة أعلى معدل من السماد النتروجينى (١٠٠.٥ كجم نتروجين / فدان) وأعلى معدل من السماد البوتاسى (٤٨ كجم بو٢أ /فدان) حققا أعلى قيمة لمحصول الجذور (٣٤.٩٨ ، ٢٩.٣٩ طن / فدان) ومحصول العرش(٢٨.٧٣، ٢٢.٥٣ طن / فدان) و محصول السكر (٤.٧٦ ، ٣.٨٢ طن / فدان) على التوالى.

– كما وجد أن الزيادة فى السماد النتروجينى المضاف الى المعدل ١٠٠.٥ كجم ن / فدان والسماد البوتاسى الى المعدل ٣٢ كجم بو٢أ / فدان حققا زيادة جوهرية فى كل من النسبة المئوية للمواد الصلبة الذائبة الكلية والنسبة المئوية للسكروز كعناصر جودة

– أما نسبة النقاوة وجد أنها لا تتأثر بإختلاف كمية السماد المضافة لكل من السماد النتروجينى أو البوتاسى .

– سجلت أعلى نسبة للمواد الصلبة الذائبة الكلية (٢١.٣٧ و ٢٠.٤٣ %) وأعلى نسبة للسكروز (١٦.٩٠ و ١٦.٣٦%) بإضافة ١٠٠.٥ كجم نتروجين ، ٣٢ كجم بو٢أ / فدان) على التوالى .

– كذلك وجد أن الزيادة فى المعدلات المضافة لكل من السماد النتروجينى والسماد البوتاسى يزيد جوهريا نسبة الشوائب (الصوديوم، البوتاسيوم، الفا أمينو نتروجين، ونسبة السكر المفقود) فى عصير الجذور وخفض الجودة.

– ومن نتائج المعاملات المختلفة للتأثير المشترك للسمادين تحت الدراسة وجد أن إضافة ١٠٠.٥كجم نتروجين/ فدان + ٤٨ كجم بو٢أ/ فدان هى أفضل المعاملات السمادية تحت ظروف التجربة حيث حققت أعلى محصول للجذور وأعلى جودة لمحصول بنجر السكر الصنف ماجريبل عديد الأجنة.