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EFFECT OF POTASSIUM, BIO AND MINERAL NITROGEN FERTILIZER ON YIELD AND QUALITY OF SUGAR BEET UNDER NORTH DELTA CONDITION

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ABSTRACT

Two field experiments were carried out during 2015/16 and 2016/17 growing seasons at Sidy Ghazy , Kafr El-Sheikh Governorate (31°06' 42"N, 30°56'45"E, 17 m a.s.l) Egypt, to study the yield and quality characteristics of sugar beet plant as affected by potassium ,bio and mineral nitrogen fertilizer under North Delta conditions. A spilt plot design with three replication was used. The main plots were randomly assigned to the three potassium fertilizer rates (24, 48 and 72 kg K_2 O/fed) whereas the five bio and mineral nitrogen fertilizer rates (70 kg N/fed, 90 kg N/fed, 70 kg N/fed + cerealin, 90kg N/fed + cerealin and cerealin alone) were randomly arranged in the sub-plots. The obtained results showed that applications of 48 and/or 72 kg K_2 O/fed significantly exhibited higher values of root fresh weight kg/plant, top fresh weight kg/plant, root yield t/fed. While the applications of 48 kg K_2 O/fed obtained the highest values of gross sugar percentage (%), gross sugar yield t/fed, white sugar percentage (%) and white sugar yield t/fed as well as juice purity. The results indicated that increasing nitrogen rate increased impurities, losses sugar % and its yield in beet root. Increasing N rate from (70 to 90 kg N/fed + cerealin) decreased white sugar % and its yield and gave the highest values of the impurities (K, Na and α amino N). The applications of 70 kg N/fed + cerealin markedly increased root and top weight/plant, root and top yield t/fed , gross sugar and white sugar t/fed. Generally, applying 48 kg K_2O/fed + 70 kg N/fed + cerealin could recommended to obtained the highest sugar beet yield and quality under north delta condition.

Key words: bio and mineral**,** gross sugar percentage**,** juice purity**,** impurities**,** quality**,** sub-plots**.**

INTRODUCTION

Sugar beet (*Beta vulgaris* L.) is one of the most important sugar crops in Egypt. Sugar beet was developed as a winter crop not only in fertile soils, but also in poor, saline and calcareous soils. It could be economically sown in newly reclaimed soils.

Potassium fertilization is important for sugar beet particular in North Delta soils. Potassium plays a significant role in bio synthesis and transfer sucrose to storage roots in sugar beet (**winter *et al*., 1996**) it is assumed that (p) and (K) fertilizing increases booth yield and beet quality. In general, potassium increases root yield and sugar yield. **Draycott (2006)** pointed out that K plays essential roles in enzyme activation, protein synthesis, osmoregulation, energy transfer, cation-anion balance and stress resistance. **Mehran and Samad (2013)** showed that increasing K rates significantly increased root and foliage fresh weight and sugar yield of sugar beet plants.

Nitrogen is the most important fertilizer element. The amount of Nitrogen fertilizer needed by sugar beet has been the subject of many experiments in many sugar beet growing countries**. Laure (1995)** found that increasing nitrogen rates has significant effect on K, Na and α –amino nitrogen in roots. **Abo El-Wafa (2002)** mentioned that applying N at 60kg/fed. At three equal doses increased sucrose percentage of sugar beet. **Marinkovic *et al*. (2010)** and **Stevens *et al*. (2011)** Who indicated that the increase in root and sugar yield as a result of increasing nitrogen fertilizer levels may be due to the importance of nitrogen as one of the macronutrient elements for plant nutrition and its role in increasing vegetative growth. **Makhlouf and Abd El-All (2017)** who noticed that root diameter ,Na , k and α-amino N contents , root and sugar yields t/fed were significantly increased by increasing N level from 80-120 kg N/fed.

In many cases inoculation with N_2 fixing bacteria promoted growth and yield of important crops. **Abo El-Fotoh *et al*. (2000)** who reported that the lowest values of white sugar were obtained from using bio fertilizer alone as a source of nitrogen.

Hassouna and Hassanain (2000) showed that combination of inoculation and mineral nitrogen fertilization generally gave a positive response to root, top and sugar yield .**Bassal *et al* (2001)** noticed that addition of 60 kg N/fed + cerealin had significantly increased top root and sugar yields as well as sucrose percentage. **Zalat, *et al*. (2002)** observed that fertilization with 90 or 60 kg/fed. as mineral N + bio-fertilizer (Cerealin) produced an increases in root, top and sugar yield. **Ramadan, *et al.* (2003), Sharaf (2012) and Mmasri *et al.* (2015).** Reported that nitrogen level at rate 120 kg N/fed significantly increased LAI, root weight / plant and K, Na and α-amino N as well as root and sugar yield t/fed. **Badr (2004)** found that supplying sugar beet soil with 70 kg N/fed attained high values of sucrose%, extractable white sugar % and purity%.

The objective of the research was to study the effect of potassium, bio and mineral Nitrogen fertilizer on sugar beet yield and quality under North Delta condition.

MATERIALS AND METHODS

Two field experiments were conducted at Sidy Ghazy (31°06' 42"N, 30°56'45"E, 17 m a.s.l), Kafr El sheikh, Egypt, during the two successive seasons 2015/16, and 2016/17. The objective of investigation is to study the effect of bio and mineral nitrogen and potassium fertilizer on yield and quality of sugar beet under North Delta condition. Soil samples were randomly taken from the experimental site at a depth of 30 cm from soil surface and were prepared for both physical and chemical properties which are presented in **Table (1)**. The preceding summer crop was corn in both seasons. Soils were fertilized with 30kg P_2O_5 /fed in the form of calcium super phosphate (15.5% p_2o_5) during soil preparation. Seeds of multigerm sugar beet cultivar "kawemira" were planted by hand in hills with approximately 3-4 seed balls per hill. Plants were thinned to one plant per hill after 35 days from sowing (4 leaf/plant). Other cultural practices were done as recommended in sugar beet fields. A split plot design with three replications was used in both seasons. The experiment included 15 treatments (three potassium fertilizer rates (24, 48 and 72 kg K_2O/fed) were distributed at random in the main plots in from of potassium sulphate (48%K_2O) and added during soil preparation .While the five bio and mineral Nitrogen fertilizer 70, 90, 70 + cerealin, 90 + cerealin and cerealin only kg N/fed were distributed at random in the sub plots. Nitrogen was applied in form of urea (46%N) at rate 70 and 90 kg / fed at two equal doses at 35 and 70 days after sowing. The bio fertilizer used in the present study produced by the General Organization for Agriculture Equalization fund, of Ministry of Agriculture. It consists of N_2 fixing bacteria e.i., cerealin (*Azospirillum basilense+ Baccillus polymyxa*).

The bio fertilizer were prepared by adding equal amount of these micro – organisms to carrier material , Arabic gum was milted in amount of warm water and was added to sugar beet seeds ,mixed and carefully spread over plastic sheet far from the sun effect for short time before sowing, then after sowing the soil was irrigated. The bio fertilizer was added at a rate of 2 kg /fed. Plot area was 16.8 m^2 comprised of 7 rows, 4 m long and 60 cm apart. The collected data in both seasons involved the following traits. At maturity (210 days from sowing), five guarded rows from each plot were harvested, uprooted, topped and weighed at both seasons ten kg roots were sent to Delta sugar company to determine all sugar quality characters . While root length, root diameter, root fresh weight and top fresh weight were determined in five plants from yield of five guarded rows to estimate the following:

I- Yield and its components:-

Root length (cm), Root diameter (cm), Root fresh weight (kg/ plant), Top fresh weight (kg /plant), Root yield (t/ fed) and Top yield (t /fed).

II- Quality parameters:-

All quality parameters were determined in Delta sugar company limited laboratories at El- Hamaul, Kafr El-shaiekh Governorate according to the methods of Mc **Ginnus (1971).**

*Gross sugar %: Juice sugar content of each treatment was determined by means of an automatic sugar polarmetric according to **Mc Ginnus (1971)**

*Extractable white sugar%: Corrected sugar content (white sugar) of beets was calculated by linking the beet non-sugar, K, Na and α amino N (expressed as mill equivalent /100g of beet) according to **Harvey and Dutton (1993)** as follow;-

ZB = pol - [0.343 (K + Na) + 0.094 Am N+ 0.29]

Where:

ZB = corrected sugar content (%per beet) or extractable white sugar

Pol= gross sugar %

Am N = α amino Nitrogen determined by the “blue number method”

*Juice purity percentage (QZ %): QZ= (ZB/Pol) x100

*Soluble non sugar content (Impurities): The soluble non sugar (potassium, sodium and α amino Nitrogen (meq/100g of beet) in roots were determined by means of an automatic sugar polarimetric.

*Gross sugar yield (t/fed) = root yield (t/fed) X gross sugar %

*White sugar yield (t/fed) = root yield (t/fed) X white sugar %

*Losses sugar yield (t/fed) = root yield (t/fed) X loss sugar %

*Losses sugar percentage (%) = gross sugar % - white sugar %

Statistical analysis

All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the spilt plot design as published by **Gomez and Gomez (1984)** using statistical package (MSTAT C). Least Significant Differences (LSD) method was used to test the deference between treatments means at 5% level of probability by **Snedecor and Cochran (1980).**

Table (1): Soil physical and chemical analysis of the experimental site in 2015/16 and 2016 /17 seasons.

Determination	Season	
	2015 / 2016	2016 / 2017
Physical Analysis		
Sand %	18.10	19.20
Silt %	33.61	31.20
Clay %	48.29	49.60
Texture class	Clay	Clay
Chemical Analysis		
pH	8.10	8.20
EC (m. mhos / cm.)	3.35	3.40
Organic matter %	1.89	1.93
Available N ppm	18.20	18.31
Available P ppm	6.90	6.50
Available K ppm	289.6	270.2
Cations (meq / L)		
Ca	2.45	2.50
Mg	2.80	2.85
K	0.45	0.35
Na	6.70	6.75
B	0.40	0.37
Cu	0.50	0.41
Fe	0.76	0.80
Mn	1.92	1.98
Mo	.025	.023
Zn	0.43	0.39
Anions (meq/ L.)		
HCO^-_3	6. 20	6.22
CL^-	6.00	6.00
So_4^-	0.20	0.23
Co_3^-	0.00	0.00

RESULTS AND DISCUSSION

I- Yield and its components:-

1-Root length (cm) and root diameter (cm):

The obtained results in **Table (2)** showed that potassium levels had no significant effect on root length in both seasons.

Root length was significantly affected with bio and mineral Nitrogen levels in the first season only. Results showed superior in stalk length from adding nitrogen fertilizer than bio-fertilizer alone. The increase in root length may be due to cell division and elongation for the promotion nitrogen on meristimic activity of plants. The previous results are in harmony with these reported by **Sultan *et al.* (1999) Kindle (2002), Tsiatas and Moslaris (2009).**

The highest root length (42.63 cm) was obtained from 90 kg N/fed + cerealin in the first season. The interaction between potassium, bio and mineral nitrogen affected significantly on root length (cm) at the first season only. The highest root length (45.20 cm) was obtained from 72 kg K_2O/fed + 90 N kg /fed + cerealin.

Table (2): Root length (cm) and root diameter (cm) as affected by potassium, bio and mineral nitrogen rates and their interaction in 2015/16 and 2016/17 seasons.

(A) Potassium rates	Root Length (cm)											
	(B) Bio and mineral Nitrogen Rate (kg N/fed)											
	2015/16 Season						2016/17 Season					
(kg K_2o/fed)	70	90	70 + cerealin	90 + cerealin	cerealin	Mean	70	90	70 + cerealin	90 + cerealin	cerealin	Mean
24	41.37	40.17	43.17	39.77	42.15	41.33	42.23	42.50	44.83	41.97	39.53	42.21
48	41.00	41.77	44.83	42.93	40.07	42.12	40.97	43.81	40.57	43.30	42.10	42.15
72	40.67	41.80	38.73	45.20	39.57	41.19	39.52	39.97	40.97	41.90	40.83	40.64
Mean	41.01	41.25	42.24	42.63	40.60		40.91	42.09	42.12	42.39	40.82	
LSD at 5%												
A	NS						NS					
B	1.03						NS					
A x B	1.79						NS					
(A) Potassium rates	Root Diameter (cm)											
	(B) Bio and mineral Nitrogen Rate (kg N/fed)											
	2015/16 Season						2016/17 Season					
(kg K_2o/fed)	70	90	70 + cerealin	90 + cerealin	cerealin	Mean	70	90	70 + cerealin	90 + cerealin	cerealin	Mean
24	14.10	13.97	14.54	14.80	10.08	13.50	14.90	14.98	15.22	15.55	10.30	14.19
48	14.30	14.48	14.76	15.25	10.50	13.86	14.82	15.03	15.42	15.52	10.45	14.25
72	14.28	14.58	15.12	15.42	10.57	13.99	14.50	14.80	15.32	15.61	10.55	14.16
Mean	14.23	14.34	14.81	15.16	10.38		14.74	14.94	15.32	15.56	10.43	
LSD at 5%												
A	0.16						NS					
B	0.26						0.14					
A x B	NS						0.24					

Concerning root diameter, the results revealed that root diameter was significantly affected by potassium fertilizer in the first season only. The highest root diameter (13.99cm) was obtained from (72kg K_2O/fed). Such increase in root diameter could be due to its favorable effects on the vegetative growth of plants through enhancing photo synthesis **Milford *et al.* (2000).**

Applying Bio and mineral nitrogen fertilizer together significantly affected root diameter at both seasons. The highest root diameter (15.16 and 15.56 cm) were obtained from adding 90kg N + cerealin. This increase amounted to (46.05 and 47.27%) over adding bio-fertilizer alone in both seasons. These results are in harmony with **Hilal (2005)** and **Ramadan *et al.* (2003).**

The interaction between potassium, bio and mineral nitrogen fertilizer affected significantly on root diameter (cm) at the second season only. The highest root diameter (15.61 cm) was obtained from 72 kg K_2O/fed + 90 kg N/fed + cerealin.

2- Root fresh Weight (kg/plant) and top fresh weight (kg/plant):

The obtained results in **Table (3)** showed that root fresh weight was significantly affected by potassium application in the first season only. The highest root fresh weight (1.02 kg/plant) was obtained from 48 kg K_2O/fed.

Root fresh weight /plant was significantly affected by bio and mineral nitrogen in both seasons **Table (3)**. The highest root fresh weight /plant (1.13 and 1.15 kg/plant)) obtained from applied (90kg N/fed.+ cerealin) in both seasons while the lowest root fresh weight (0.65 and 0.66 kg/plant) were obtained from added bio fertilizer only .The interaction between potassium, bio –and mineral Nitrogen fertilizer affected root fresh weight **Table(3)**. The highest root fresh weight/plant (1.16 and 1.16 kg/plant) were obtained from (48 kg K_2O/fed +70 kg N /fed +cerealin) in the two seasons.

The obtained results in **Table (3)** indicated that potassium fertilizer had significant effect on top fresh weight / plant at the both seasons. The highest top fresh weight /plant (0.48 and 0.50 kg / plant) obtained from 72 kg K_2O/fed).

Top fresh weight kg / plant had significantly affected by bio – and mineral nitrogen in the both seasons. The highest top fresh weight (0.58 and 0.57 kg / plant) were obtained from (90kg N / fed + cerealin).

The achieved results show that sugar beet respond to bio + N fertilizers. This increase may be due to stimulated vegetative growth of sugar beet plants to Nitrogen. Thus reflecting the important rule of Nitrogen in building up photosynthetic area of beet plants and more dry matter accumulation. These results are in harmony with those obtained by **Hassouna and Hassanein (2000) and Mohamed (2004).**

The effect of interaction between potassium, bio – and mineral Nitrogen on top fresh weight /plant in **Table (3)** was significant in both seasons the highest top fresh weight /plant (0.60 and 0.58 kg /plant) were obtained from 48 kg K_2O/fed + 90 kg N/ fed + cerealin in the first season, and from 72 kg K_2O/fed + 90 kg N/fed + cerealin in the second season.

Table (3): Root fresh weight (kg/plant) and top fresh weight (kg/plant) as affected by potassium, bio and mineral nitrogen rates and their interaction in 2015/16 and 2016/17 seasons.

(A) Potassium rates	Root fresh weight (kg/plant) (B) Bio and mineral Nitrogen Rate (kg N/fed)											
	2015/16 Season						2016/17 Season					
(kg K_2o/fed)	70	90	70 + cerealin	90 + cerealin	cerealin	Mean	70	90	70 + cerealin	90 + cerealin	cerealin	Mean
24	1.02	1.06	1.14	1.13	0.64	1.00	1.09	1.11	1.14	1.15	0.65	1.03
48	1.08	1.07	1.16	1.14	0.65	1.02	1.13	1.15	1.16	1.15	0.67	1.05
72	1.05	1.03	1.05	1.12	0.66	0.98	1.12	1.14	1.13	1.14	0.66	1.04
Mean	1.05	1.05	1.12	1.13	0.65		1.11	1.13	1.14	1.15	0.66	
LSD at 5%												
A	0.02						NS					
B	0.03						0.02					
A x B	0.05						0.03					

(A) Potassium rates	Top fresh weight (kg/plant) (B) Bio and mineral Nitrogen Rate (kg N/fed)											
	2015/16 Season						2016/17 Season					
(kg K_2o/fed)	70	90	70 + cerealin	90 + cerealin	cerealin	Mean	70	90	70 + cerealin	90 + cerealin	cerealin	Mean
24	0.51	0.49	0.51	0.58	0.27	0.47	0.49	0.51	0.55	0.57	0.27	0.48
48	0.39	0.50	0.54	0.60	0.26	0.46	0.54	0.53	0.54	0.56	0.28	0.49
72	0.48	0.51	0.59	0.56	0.24	0.48	0.55	0.56	0.52	0.58	0.29	0.50
Mean	0.46	0.50	0.55	0.58	0.26		0.53	0.53	0.54	0.57	0.28	
LSD at 5%												
A	0.01						0.01					
B	0.02						0.02					
A x B	0.03						0.03					

3-Root yield (t/fed) and top yield (t/fed):

The results in **Table (4)** showed that root yield (t/fed) was significantly affected by potassium applications at both seasons. The highest root yield (30.58 and 31.50 t/fed) were obtained from 72 kg K_2O/fed in the first season, and from 48 kg K_2O/fed in the second season. On the other hand, the lowest root yield (29.73 and 30.83 t/fed) were obtained from 24 kg K_2O/fed. The above results were in agreement with those obtained by **Zalat (1986), Ibrahim, *et al*. (2002), Cakmak (2005)** and **Abd-El-motagally and Attia (2009)** who found that potassium significantly increased root yield. Such increase in root yield may be attributed to the increase of dry matter, transportion accumulation and to the same extent to the increase of root diameter. Also potassium had a beneficial effect in translocation of carbohydrates to the storage.

Data in **Table (4)** showed that bio and mineral Nitrogen fertilizer levels have a pronounced effect on root yield t/fed. Nitrogen increased root yield through increasing dry matter accumulation and root size as well as root weight. Results revealed that (34.37 and 34.36 t/fed) were the highest root yield in the two seasons).They obtained from 90kg N /fed + cerealin while the lowest root yield t/fed (20.09 and 19.87 t/fed.) were obtained from added cerealin only in both seasons. The above results were in agreement with those obtained by **Badr (2004), Zalat *et al* (2002), Mohamed (2004), Stevens *et al* (2008) and Hergert (2010)**.

The interaction between potassium, bio and mineral Nitrogen affected significantly on root yield (t/fed) **Table (4)**. The highest root yield t/fed. (34.91 and 34.83 t/fed.) were obtained from 72 kg K_2O/fed + 90kg N/fed + cerealin in the first season and from (48kg K_2O + 90kg N/fed + cerealin) in the second season, respectively.

Potassium fertilizer had no significant effect on top yield at the both seasons **Table (4)**.

Bio and mineral Nitrogen had significant effect on top yield t/fed at the both seasons .The highest top yield (17.27 and 17.30 t /fed.) were obtained from (90 kg N /fed + cerealin). The previsions results are in harmony with these reported by **Saric *et al* (1991), EL- esawy (1996) and Stevens *et al* (2008)**who found that interaction sugar beet with azotobacter trains significantly affected dry mater yield of root and top.

The effect of interaction between potassium, bio and mineral N on top yield (t/fed) was significant at the second season only **Table (4)**. The highest top yield (17.42 t/fed) was obtained from 72 kg K_2O/fed + 90 kg N/fed + cerealin.

Table (4): Root yield (t/fed) and top yield (t/fed) as affected by potassium, bio and mineral nitrogen rates and their interaction in 2015/16 and 2016/17 seasons.

(A) Potassium rates (kg K_2O/fed)	Root Yield (t/fed)											
	(B) Bio and mineral Nitrogen Rate (kg N/fed)											
	2015/16 Season						2016/17 Season					
	70	90	70 + cerealin	90 + cerealin	cerealin	Mean	70	90	70 + cerealin	90 + cerealin	cerealin	Mean
24	30.70	31.03	33.74	33.50	19.70	29.73	32.60	33.22	34.47	34.47	19.37	30.83
48	32.30	31.97	34.26	34.71	19.67	30.58	33.62	34.68	34.20	34.83	20.16	31.50
72	31.40	31.70	34.03	34.91	20.90	30.59	33.47	34.65	34.10	33.79	20.07	31.22
Mean	31.47	31.57	34.01	34.37	20.09		33.23	34.18	34.26	34.36	19.87	
LSD at 5%												
A	0.04						0.39					
B	0.77						0.28					
A x B	1.33						0.48					
(A) Potassium rates (kg K_2O/fed)	Top Yield (t/fed)											
	(B) Bio and mineral Nitrogen Rate (kg N/fed)											
	2015/16 Season						2016/17 Season					
	70	90	70 + cerealin	90 + cerealin	cerealin	Mean	70	90	70 + cerealin	90 + cerealin	cerealin	Mean
24	15.29	14.76	15.24	17.47	8.27	14.21	14.99	15.35	16.42	17.23	8.08	14.41
48	11.77	14.74	16.24	17.49	8.24	13.70	16.14	16.02	16.28	17.24	8.25	14.79
72	14.43	15.21	17.60	16.84	8.03	14.42	16.47	16.45	16.03	17.42	8.27	14.93
Mean	13.83	14.90	16.36	17.27	8.18		15.87	15.94	16.24	17.30	8.20	
LSD at 5%												
A	NS						NS					
B	1.42						0.11					
A x B	NS						0.19					

II-Quality parameters:-

1-Gross sugar percentage (%) and gross sugar yield (t/fed):

Potassium rates had a highly significant effect on gross sugar % and gross sugar yield t/fed.

The highest gross sugar % (18.04 and 18.12%) were obtained from (48 kg K_2O/fed) at both seasons and the highest gross sugar yield (5.53 and 5.75 t/fed) were also obtained from (48kg K_2O/fed) at the both seasons. **Table (5).** These results agree with **EL-sherif (1998), Omar *et al.* (2002) and CakMak (2005).**

Table (5): Gross sugar percentage (%) and gross sugar yield (t/fed) as affected by potassium, bio and mineral nitrogen rates and their interaction in 2015/16 and 2016/17 seasons.

(A) Potassium rates	Gross sugar percentage (%)											
	(B) Bio and mineral Nitrogen Rate (kg N/fed)											
	2015/16 Season						2016/17 Season					
($kg K_2O/fed$)	70	90	70 + cerealin	90 + cerealin	cerealin	Mean	70	90	70 + cerealin	90 + cerealin	cerealin	Mean
24	17.67	17.56	18.57	18.50	17.45	17.95	17.59	17.72	18.67	18.51	17.68	18.03
48	17.54	17.62	18.97	18.51	17.55	18.04	17.83	18.62	18.94	18.57	16.63	18.12
72	17.81	17.39	18.28	18.34	17.32	17.83	17.87	17.61	18.67	18.24	17.47	17.97
Mean	17.67	17.52	18.61	18.45	17.44		17.76	17.98	18.76	18.44	17.26	
LSD at 5%												
A	0.04						0.07					
B	0.04						0.04					
A x B	0.08						0.08					
(A) Potassium rates	Gross sugar Yield (t/fed)											
	(B) Bio and mineral Nitrogen Rate (kg N/fed)											
	2015/16 Season						2016/17 Season					
($kg K_2O/fed$)	70	90	70 + cerealin	90 + cerealin	cerealin	Mean	70	90	70 + cerealin	90 + cerealin	cerealin	Mean
24	5.42	5.45	6.27	6.20	3.44	5.35	5.73	5.89	6.44	6.38	3.42	5.57
48	5.67	5.63	6.50	6.42	3.45	5.53	5.99	6.46	6.48	6.47	3.35	5.75
72	5.59	5.51	6.22	6.40	3.62	5.47	5.98	6.10	6.37	6.16	3.51	5.62
Mean	5.56	5.53	6.33	6.34	3.50		5.90	6.15	6.43	6.34	3.43	
LSD at 5%												
A	0.08						0.09					
B	0.13						0.05					
A x B	0.23						0.09					

Bio - and mineral Nitrogen fertilizer significantly affected gross sugar % and gross sugar yield t/fed in the both seasons respectively where 70 kg N/fed + cerealin gave the highest gross sugar percentage (18.61 and 18.76 %). While, the highest gross sugar yield were obtained from 90 kg K_2O/fed + cerealin (6.34 t/fed) at the first season and from 70 kg K_2O/fed + cerealin (6.43 t/fed) at the second season. The lowest gross sugar percentage and yield (17.44 and 17.26 %) and (3.50 and 3.43 t/fed) were obtained from bio fertilizer only (cerealin). This results were confirmed by **Abo el Fotoh *et al* (2000)**, **Mohamed (2004)** and **Mekdad (2012)** who indicated that sugar yield responded to inoculation with free-living nitrogen fixing bacteria as well as improving crop quality.

Sultan *et al*. (1999) found that it could be concluded that inoculation of beet seeds by biological fertilizers with mineral nitrogen might be recommended to gain maximum sugar yield. Similar reports were found by **basal *et al*. (2001)** and **Zalat *et al*. (2002)**.

The interaction effect between potassium, bio and mineral Nitrogen fertilizers on gross sugar % and gross sugar yield t/fed **Table (5)** during the two seasons was highly significant. The highest gross sugar % (18.97 and 18.94%) were obtained from 48 kg K_2O/fed + 70kg N /fed + cerealin) in the two seasons. Also, the highest gross sugar yield (6.50 and 6.48 t/fed) were obtained from (48 kg K_2O/fed + 70 N/fed + cerealin) at both seasons **Table (5)**. Data in Table (5) showed that bio fertilization (cerealin) alone gave the lowest gross sugar percentage and its yield under all level of k fertilizer.

2-white sugar percentage (%) and white sugar yield (t/fed.):

The white sugar yield is an important yield parameter of sugar beet because it is the final form of sugar that the consumer use. It was reported by **Harvey and dotton (1993).**

The mean value of extractable white sugar % and white sugar yield (t/fed) at harvest as affected by potassium bio – and mineral Nitrogen and their interaction **Table (6)**. Potassium fertilizer hade a highly significant effect on white sugar % and yield in both seasons. The highest white sugar percentage (14.49 and 14.66%) were obtained from 24kg K_2O/fed in the first seasons and from (48 kg K_2O/fed) in the second season. The highest white sugar yield (4.42 and 4.62 t/fed) were obtained from (48 kg K_2O/fed.) in the two seasons.

The proportion and amount of K in the beet plant may also be important because of the positive correlation between K fertilization and sucrose concentration in the root.

Regarding bio – and mineral nitrogen fertilizers, data in **Table (6)** showed significant increases in white sugar %. Where (70 kg N /fed + cerealin) gave the highest white sugar percentage (14.91 and 15.38 %) and gave also the highest white sugar yield (5.07 and 5.27 t/fed) in the both seasons. While the lowest white sugar % were obtained from 90 kg N/fed + cerealin in the both seasons (13.80 and 14.10%) while bio fertilizer (cerealin) alone gave the lowest white sugar yield (2.86 and 2.86 t/fed.) These results were in accordance with those reported by **Mohamed (2004) and zengin *et al*. (2009)** who found that application of 60 kg N/fed with cerealin produced the highest white sugar percentage. **Abo El-Fotoh et al. (2000)**, **Bassal et al. (2001)** and **Zalat et al. (2002)** who reported that white sugar was significantly affected by bio-fertilizers + mineral nitrogen.

The interaction among potassium, bio and mineral Nitrogen fertilizer had significant effects on white sugar % and white sugar yield t/fed. in both seasons. The highest white sugar percentage (15.17 and 15.56%) were obtained from (24 kg K_2O/fed + 70 kg N/fed + cerealin) in the first season and from (48 kg K_2O/fed. + 70 kg N/fed. +cerealin) in the second season. The highest white sugar yield (5.16 and 5.32 t/fed) were obtained with (48 kg K_2O/fed +70 kg N /fed. + Cerealin) at the first and the second seasons respectively as shown in **Table (6)**

Table (6): White sugar percentage (%) and white sugar yield (t/fed) as affected by potassium, bio and mineral nitrogen rates and their interaction in 2015/16 and 2016/17 seasons.

(A) Potassium rates	White sugar percentage (%)											
	(B) Bio and mineral Nitrogen Rate (kg N/fed)											
	2015/16 Season						2016/17 Season					
(kg K_2O/fed)	70	90	70 + cerealin	90 + cerealin	cerealin	Mean	70	90	70 + cerealin	90 + cerealin	cerealin	Mean
24	14.18	15.04	15.17	13.99	14.05	14.49	14.26	15.02	15.28	14.19	14.16	14.58
48	14.07	14.98	15.06	13.80	14.29	14.44	14.20	14.94	15.56	14.15	14.45	14.66
72	13.68	14.64	14.49	13.62	14.41	14.17	14.07	14.69	15.31	13.96	14.53	14.51
Mean	13.98	14.89	14.91	13.80	14.25		14.18	14.88	15.38	14.10	14.38	
LSD at 5%												
A	0.09						0.11					
B	0.12						0.07					
A x B	0.12						0.21					
(A) Potassium rates	White sugar yield (t/fed)											
	(B) Bio and mineral Nitrogen Rate (kg N/fed)											
	2015/16 Season						2016/17 Season					
(kg K_2O/fed)	70	90	70 + cerealin	90 + cerealin	cerealin	Mean	70	90	70 + cerealin	90 + cerealin	cerealin	Mean
24	4.35	4.67	5.12	4.69	2.77	4.32	4.65	4.99	5.27	4.89	2.74	4.51
48	4.54	4.79	5.16	4.79	2.81	4.42	4.77	5.18	5.32	4.93	2.91	4.62
72	4.30	4.64	4.93	4.75	3.01	4.33	4.71	5.09	5.22	4.72	2.92	4.53
Mean	4.40	4.70	5.07	4.74	2.86		4.71	5.09	5.27	4.85	2.86	
LSD at 5%												
A	0.06						0.08					
B	0.12						0.05					
A x B	0.2						0.08					

3-Loss sugar percentage and loss sugar yield (t/fed.):

The effect of potassium, bio-and mineral Nitrogen fertilizer and their interaction on loss sugar percentage and loss sugar yield t/fed are presented in **Table (7)**. Potassium had no significant effect on loss sugar % at the second season and on loss sugar yield at the first season. The highest loss sugar percentage (3.66%) at the first season and the highest loss sugar yield (1.12 t/fed) were obtained from 72 kg K_2O/fed at the second season.

The effect of bio and mineral Nitrogen fertilizer on loss sugar percentage and its yield over the two seasons showed in **Table (7)** The result cleared that bio – and N fertilizer had a significant effect on loss sugar % and loss sugar yield at the two seasons, the highest loss sugar percentage (4.65 and 4.34%) and the highest loss sugar yield (1.60 and 1.50 t/fed) were obtained from 90 kg N/fed + cerealin. The lowest loss sugar % and sugar yield were obtained from bio fertilization (cerealin) alone.

The results indicated that increasing Nitrogen level increased impurities, loss sugar % and its yield in beet root. Such effect may be due to the obvious increase in impurities especially K, Na and α-amino N. **Tsiatas and Moslaris (2009).**

The interaction between potassium, bio and mineral nitrogen fertilizer **Table(7)** had no significant effect on loss sugar percentage and loss sugar yield at the first season but had significant effect at the second season. The highest loss sugar percentage (4.42%) and the highest loss sugar yield (1.56 t/fed) were obtained from 72 kg K_2O/fed + 90 kg N/fed + cerealin.

4-juice purity %:

Data in **Table (8)** showed that potassium, bio – and mineral Nitrogen fertilizer levels had pronounced effect on juice purity %. Potassium fertilizer had significant effect on juice purity at the second season only **Table (8)**. The highest juice purity (81.02 %) was obtained from 48kg K_2O/fed. **Bosmark (1993), Samaarenda (2003) and Zengin *et al* (2009)** reported that the chemical characteristics of sugar beet juice was mainly affected by the sugar crystallization processes with low contents of sodium, potassium and α-amino N and betaine contents.

Concerning the effect of bio and mineral nitrogen fertilizer on juice purity %, they had a significant effect on juice purity at the second season only. Data of **Table (8)** showed that inoculation seeds with cerealin gave the highest purity % (83.38 %) **Abdulla (1999), Zalat *et al* (2002) and Stevens *et al.* (2011)** pointed that increasing Nitrogen fertilizer levels attended to reduce juice purity %.

Sultan *et al*. (1999) and **abo El-Fotoh *et al*. (2000).** They reported that the drop in juice purities mostly are due to the increase in the concentration of amino compounds caused by excessive uptake of nitrate.

The interaction between potassium, bio and mineral Nitrogen had also significant effect on juice purity at the second season only presented at **Table (8)**. The highest juice purity % (86.89 %) was obtained from 48 K_2O/fed + cerealin at the second season.

Table (7): Loss sugar percentage (%) and loss sugar yield (t/fed) as affected by potassium, bio and mineral nitrogen rates and their interaction in 2015/16 and 2016/17 seasons.

(A) Potassium rates	Loss sugar percentage (%)											
	(B) Bio and mineral Nitrogen Rate (kg N/fed)											
	2015/16 Season						2016/17 Season					
(kg K_2o/fed)	70	90	70 + cerealin	90 + cerealin	cerealin	Mean	70	90	70 + cerealin	90 + cerealin	cerealin	Mean
24	3.49	3.40	3.40	4.51	2.52	3.46	2.70	3.33	3.39	4.32	3.52	3.45
48	3.47	3.26	3.91	4.71	2.64	3.60	3.68	3.63	3.38	4.28	2.18	3.43
72	4.13	2.91	3.79	4.72	2.75	3.66	2.92	3.80	3.36	4.42	2.94	3.49
Mean	3.70	3.19	3.70	4.65	2.64		3.10	3.59	3.38	4.34	2.88	
LSD at 5%												
A	0.12						NS					
B	0.12						0.04					
A x B	NS						0.07					
(A) Potassium rates	Loss sugar yield (t/fed)											
	(B) Bio and mineral Nitrogen Rate (kg N/fed)											
	2015/16 Season						2016/17 Season					
(kg K_2o/fed)	70	90	70 + cerealin	90 + cerealin	cerealin	Mean	70	90	70 + cerealin	90 + cerealin	cerealin	Mean
24	0.78	1.07	1.15	1.51	0.67	1.04	0.90	1.17	1.09	1.49	0.68	1.06
48	0.84	1.12	1.34	1.63	0.64	1.12	1.28	1.16	1.22	1.45	0.44	1.11
72	0.87	1.30	1.29	1.65	0.61	1.14	1.01	1.15	1.27	1.56	0.59	1.12
Mean	0.83	1.16	1.26	1.60	0.64		1.06	1.16	1.19	1.50	0.57	
LSD at 5%												
A	NS						0.01					
B	0.04						0.01					
A x B	NS						0.02					

Table (8): Juice purity (%) as affected by potassium, bio and mineral nitrogen rates and their interaction in 2015/16 and 2016/17 seasons

(A) Potassium rates (kg K_2o/fed)	Juice purity (%)											
	(B) Bio and mineral Nitrogen Rate (kg N/fed)											
	2015/16 Season						2016/17 Season					
	70	90	70 + cerealin	90 + cerealin	cerealin	Mean	70	90	70 + cerealin	90 + cerealin	cerealin	Mean
24	80.52	80.25	81.69	75.62	85.65	80.75	81.84	84.76	81.07	76.66	80.09	80.89
48	81.42	80.22	79.39	74.55	85.02	80.12	82.15	80.24	79.64	76.20	86.89	81.02
72	83.20	76.81	79.27	74.26	84.19	79.55	82.00	78.74	83.42	76.54	83.17	80.77
Mean	81.71	79.09	80.12	74.81	84.95		82.00	81.25	81.38	76.46	83.38	
LSD at 5%												
A	NS						0.63					
B	NS						0.24					
A x B	NS						0.42					

5- Soluble non – sugar (Impurities):

The non-sucrose substance in sugar beet roots include other soluble saccharides, cell wall components , proteins, free amino acids, betaine as well as organic and inorganic, ions and other nitrogen free acids. The non sugar components most relevant for “technical quality” of sugar beet are potassium, sodium and α-amino N

The soluble non- sugar K, Na and α-amino N in fresh root (meq /100 g beet) are regards impurities because they interfere with sugar extraction. Also, sodium and potassium ions plays an important role on physiological equilibrium condition in cellular solution for sugar content in sugar beet yield **Lauer (1995).**

Values of potassium, sodium and α-amino Nitrogen in fresh root (mg/100g beet) as affected by potassium, bio - and mineral nitrogen fertilizer **Table (9)**.

Potassium fertilizer had significant effect on K in fresh root at the first season only and had also a significant effect on Na also at the second season only while Potassium had no significant effect on α – amino N at the both seasons **Table (9)**. The highest value of K and Na at the 1st and 2nd season respectively were obtained from 72 kg K_2O/fed.

Concerning the effect of bio and mineral Nitrogen fertilizer in **Table (9)** revealed that bio and mineral N had significant effect on K and α-amino N in both seasons and on Na in the second season. The highest values of K, Na and α-amino N were obtained from (90kg N/ fed. + Cerealin) in both season. This results could concluded that increasing nitrogen fertilizer significantly increased K, Na and α-amino N in beet. **Kandel *et al*. (2002) and Hilal (2005).**

It was found that increasing N dose was associated with a gradual increase in root impurities, which may be due to raising of amount of applied nitrogen enhance plants to absorb more solvents from the soil solution in addition, an increase in the absorption of Na element from the soil by roots accompanied with increasing nitrogen fertilizer level, **Makhlouf and abd El - All (2017).**

The interaction between potassium, bio and mineral nitrogen had significant effect on K at the first season only and had significant effect on Na at the second season only but had no significant effect on α-amino N at both seasons, **Table (9)**. The highest value of K was obtained from 72 kg K_2O/fed + 90 kg N/fed at the first season. The highest value of Na was obtained from 72 kg K_2O/fed + 90 kg N/fed + cerealin at the second season. K, Na and α-amino N are very serious impurities in sugar beet juice which decrease extraction of white sugar in processing of the root.

Table (9): Impurities (potassium, sodium and alpha amino nitrogen meq/100g beet) contents of sugar beet as affected by potassium, bio and mineral nitrogen rates and their interaction in 2015/16 and 2016/17 seasons.

(A) Potassium rates (kg K_2o/fed)	Potassium(K) meq/100g beet											
	Bio and mineral Nitrogen(kg N/fed)											
	2015/16 Season						2016/17 Season					
	70	90	70 + cerealin	90 + cerealin	cerealin	Mean	70	90	70 + cerealin	90 + cerealin	cerealin	Mean
24	6.63	6.62	6.72	6.72	6.32	6.60	6.42	6.56	6.45	6.57	6.27	6.45
48	6.73	6.72	6.77	6.95	6.11	6.66	6.47	6.68	6.49	6.69	6.19	6.50
72	7.11	7.32	7.16	7.08	6.20	6.97	6.42	6.75	6.64	6.78	6.22	6.56
Mean	6.82	6.89	6.88	6.92	6.21		6.44	6.66	6.53	6.68	6.23	
LSD at 5%												
A	0.15						NS					
B	0.02						0.02					
A x B	0.26						NS					

(A) Potassium rates (kg K_2o/fed)	Sodium (Na) meq/100g beet											
	Bio and mineral Nitrogen(kg N/fed)											
	2015/16 Season						2016/17 Season					
	70	90	70 + cerealin	90 + cerealin	cerealin	Mean	70	90	70 + cerealin	90 + cerealin	cerealin	Mean
24	1.56	1.68	1.72	1.82	1.69	1.69	1.72	1.69	1.70	1.68	1.61	1.68
48	1.65	1.75	1.71	1.77	1.63	1.70	1.66	1.71	1.71	1.74	1.61	1.69
72	1.71	1.83	1.72	1.73	1.57	1.71	1.62	1.74	1.71	1.82	1.66	1.71
Mean	1.64	1.75	1.72	1.77	1.63		1.67	1.71	1.71	1.75	1.63	
LSD at 5%												
A	NS						0.02					
B	NS						0.02					
A x B	NS						0.04					

(A) Potassium rates (kg K_2o/fed)	Alpha amino nitrogen (α amino N) meq/100g beet											
	Bio and mineral Nitrogen(kg N/fed)											
	2015/16 Season						2016/17 Season					
	70	90	70 + cerealin	90 + cerealin	cerealin	Mean	70	90	70 + cerealin	90 + cerealin	cerealin	Mean
24	3.62	4.30	4.05	3.72	3.65	3.87	3.87	3.89	3.88	4.12	3.55	3.86
48	3.41	4.14	3.98	3.81	3.45	3.76	3.92	3.89	3.79	3.96	3.41	3.79
72	3.85	4.06	3.82	5.54	3.42	4.14	3.59	3.87	3.83	3.88	3.37	3.71
Mean	3.63	4.17	3.95	4.36	3.51		3.79	3.88	3.83	3.99	3.44	
LSD at 5%												
A	NS						NS					
B	0.65						0.24					
A x B	NS						NS					

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تأثير التسميد البوتاسي والنتروجينى الحيوي والمعدني علي محصول وجوده بنجر السكر تحت ظروف منطقه شمال الدلتا

اميرة عيد الشريف ـ كرم عبدالصادق جوده عبدالسلام ـ علي محمد علوان فاضل

معهد بحوث المحاصيل السكرية – مركز البحوث الزراعية بالجيزة- مصر

أقيمت تجربة حقلية في سيدي غازي محافظه كفر الشيخ خلال موسمى 2015 / 2016 – 2017/2016 بهدف دراسة تأثير التسميد البوتاسي والنتروجيني الحيوي و المعدني علي محصول وجودة بنجر السكر في منطقه شمال الدلتا استخدم تصميم القطع المنشقة مرة واحدة في ثلاث مكررات وزعت معدلات التسميد البوتاسى (24،48،72 كجم/فدان) في القطع الرئيسية عشوائيا في حين وزعت معدلات التسميد الأزوتي الحيوي والمعدني في القطع المنشقة (70كجم/نيتروجين /فدان، 90كجم نيتروجين / فدان، 70كجم نيتروجين / فدان+ سرياليين،90 كجم نيتروجين / فدان + سرياليين، سيرياالين فقط).

وقد أوضحت النتائج مايلي :

1.زياده معدل التسميد البوتاسى إلى 48 كجم K_2O /فدان أدى إلى زيادة سمك الجذر وكذلك زيادة محصول الجذر والسكر الكلى والابيض (طن/فدان).

2. زيادة التسميد البوتاسى له تأثير ايجابي علي خفض درجة النقاوة ورفع محتوي الجذور من الشوائب (البوتاسيوم – الصوديوم – النيتروجين الاميني).

3.اضافة التسميد النيتروجيني المعدني والحيوي أحدث زياده في قطر وطول الجذر وقد كان لاستخدام السرياليين مع 70كجم نيتروجين الحصول على أعلى محصول للسكر ونسبة النقاوة اما مع 90كجم نتروجين فقد اعطى اعلى محصول جذر وعرش.

4.يمكن التوصية بتسميد بنجر السكر بإضافة 48كجم K_2O / فدان مع إضافة 70كجم نيتروجين/ فدان بالإضافة الي السرياليين للحصول علي أعلي محصول وافضل جودة لمحصول بنجر السكر تحت ظروف شمال الدلتا.