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NITROGEN, PHOSPHORUS AND POTASSIUM REQUIREMENTS OF SUGAR BEET UNDER SANDY SOIL CONDICTION

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ABSTRACT: *Two field experiments were carried out in sandy soils during the two successive seasons of 2012/2013 and 2013/2014 at Al-Hosein Agricultural Society at 64 km, Cairo, Alexandria Road, Giza Governorate (latitude of 31.14^0 N and longitude of 31.39^0 E) to find out the effect of nitrogen, phosphorus and potassium level on productivity and quality of sugar beet crop under sandy soil conditions. The experiment included 18- treatments, which were the combination between two nitrogen levels (80 and 100 kg.N./fed) , three phosphor levels (16, 32 and 48 P_2O_5 /fed.) and three levels of potassium levels (24,36 and 48 K_2O /fed.). Results given could be summarized as follow:*

Increasing N- application from 80 to 100 kg .N/fed. significantly increased the averages of root fresh yield/fed by 10.15 % and11.54 % in the 1st and 2nd season respectively , and as well fresh weight / plant. These weights were not significantly affected by the levels of phosphorus in the two seasons. Adding 48kg. K_2O/fed. recorded the highest individual leaves and root fresh weight as well as tops and root fresh yield

Juice quality in terms of sucrose %, purity % and white sugar % was significantly decreased by the increase of levels of nitrogen. However, the sugar yield /fed. was not significantly decreases. Juice quality and theoretical sugar yield did not significantly respond to the increase of levels of phosphorus. Mean while, sucrose % and white sugar % in the 1st season only attained a positive response to the increase in the applied dose of potassium fertilizer, mean while the others juice traits criteria insignificantly affected by K- application level

It could be considered the combination of 80 kg. N./fed., 16 kg.P_2O_5/fed. and 24 K_2O_5/fed. to produce the highest sugar yield with less amount of NPK fertilizer requirement

Root yield of sugar beet attained the highest average of 37.782 tons/fed. with the combination between 36 kg K_2O/fed., with 48 kg.P_2O_5/Fed. and 80 kg.N/fed

The recommended package that produced the highest profit (L.E. 10724/ fed.) be under drip irrigation system in the sandy soil was the fertilizer combination of 80 ,16 and 24 NPK in addition to the common agricultural practices as mentioned in the experiment.

Key words: *N, P, K- Fertilizers, Sugar Beet*

INTRODUCTION

Nowadays , sugar beet is one of the most important industrial crop in Egypt. As a result to the wide extension in the agricultural area with sugar beet to narrow sugar gap ,and because of most of the expanding area are in the new reclaimed area *i.e* sandy soils and under the new irrigation systems , it has become necessary to study the fertilization requirements to attain the highest productivity and quality.

Concerning nitrogen fertilization, nitrogen concentration in leaves of sugar beet is the key factor shaping the crop canopy development, which in turn is decisive for solar energy fixation (Malnou *et al.*, 2008). Most interest in total N concentration in the storage root focuses on its technological quality (Hoffmann, 2005). However, this element can be considered as a reserve used by the storage root to prolong its further growth. Boiffin *et al.*, 1992, who underlined the effect of the sugar beet growth rate in the early stages of development on its capability to accumulate dry matter in subsequent stages. Witold *et al.*, 2012 indicates that sugar beet plants are able to compensate their rate of growth during the growing season. They also found that nitrogen concentration in sugar beet organs declined during the growing season, according to a linear-plateau regression model in leaves but exponentially in storage roots. Therefore nitrogen concentration in both organs of sugar beet significantly affected dry matter growth of leaves and the tap root. They also concluded that dry matter partitioning to the storage root is significantly related to nitrogen concentration in both leaves and the target plant organ; the linear dependence is typical for the storage root, underlying its internal conservatism.

Sugar beet yield and quality are dramatically influenced by the level of available nitrogen. Residual and fertilizer N-level allowing adequate top growth and maximize root growth and extractable sucrose concentration are desired. However, sucrose yield decreases by over-fertilizing sugar beet with more nitrogen than needed for maximum sucrose production (Hassanin and Elayas, 2000). An adequate supply of N is essential for optimum yield but excess nitrogen may result in an increase in yield of roots with lower sucrose content and juice purity. Yield was increased with applied nitrogen, but TSS, sucrose %, purity % and recoverable sugar yield per ha were significantly decreased as N level increased (Attia, 2004). Also , Horn and Fürstenfeld, 2001 showed that the uptake of nitrogen by sugar beet plants increased by increasing the application level of nitrogen, while the sugar content and juice purity were decreased.

Phosphorus functions in plants are numerous, comprising energy transfer, photosynthesis, transformation of sugars, transfer of genetic information and nutrient movement within the plant (Marschner, 1995). It is a component of nucleic acids and lipids and is important in the production and transport of sugars, fat and protein during sugar beet production. Phosphorus is especially important during early root development. A good supply of phosphorus ensures rapid root growth and good uptake of other nutrients.

It is assumed that P and K fertilizing increases both, yield and beet quality. However, a response of sugar beet to both nutrients, applied as fertilizers, depends on interaction of numerous factors. Among the most important are weather conditions during the vegetation, soil type and initial content of available forms of these nutrients Barłóg *et al.*, 2010.

Sims and Smith, 2001 reported that root yield significantly less in the control treatment (0 kg P_2O_5/ha) compared to apply others (15,30 and 45 kg P_2O_5/ha). Marinkovic *et al.,* 2008 showed that by increasing amounts of phosphorus from 50 to 100 and 150 kg P_2O_5/ha, root and sugar yields were increased.

Concerning potassium (K), it helps to regulate the amount of carbon dioxide that enters leaves for use in photosynthesis (sugar formation). Potassium improves nitrogen use effeciency since both are essential for protein formation. A shortage of potassium teamed with high night-time temperatures may cause an increase in plant respiration resulting in less sugar for storage in the roots. In addition, a balance of nitrogen and potassium is essential for improvement of yield and feed quality of sugar beet forage used for livestock feed. Potassium is involved in enzyme activation, charge balance and osmotic regulation in plants (Cakmak, 2005). In sugar beet, potassium plays a significant role in biosynthesis and transfer of sucrose to storage roots (Winzer *et al.,* 1996). Ibrahim *et al.,* 2002 found that the highest sucrose percentage and juice purity were achieved with potassium application up to 228.5 kg K2O ha-1. The beneficial effect of K-fertilization on growth, yield and quality of sugar beet was emphasized by (Ouda, 2002). The direct effect of K on yield is less marked than of nitrogen, which itself constitutes a part of the organic matter synthesized during growth. Also, K uptake is much affected by N -level and in most cases; potassium is more effective at high N- level, which is the case especially to modern high yielding varieties (Mäck and *et al,* 2007). The interaction between N and K was limited at low rates, but became more important at high rates and the best returns from one nutrient were obtained at high rates of the other. Root crops especially, have a high K- requirement. It is commonly observed that root or tuber enlargement is depressed relatively more than leaf development, when K is in short supply (Inal, 1997). In Egypt many investigations revealed that 214-262 kg N ha-1 exhibited the highest root quality, technological characters, root and sugar yields and minimized sugar losses to molasses (Hassanin and Elayas, and 2000 Ashraf, 2007). Mehran, and Samad, 2013 concluded that adding the highest level of potassium (114 kg K_2O ha-^{1}) under different rates of nitrogen significantly increased sucrose contents, recoverable sugar yield (ton ha-1) and some quality traits. Adding the highest level of nitrogen (285 kg N ha^{-1}) under different rates of potassium significantly increased sugar loss (ton ha^{-1}) and increased content and uptake of N and K in both root and foliage of sugar beet over two seasons. Increasing N level up to 285 kg N ha^{-1} (under 0.0 kg K_2O ha^{-1}) significantly increased impurities (Na, K & α-amino-N) and sugar loss percentage. In crux, N-fertilizer at a level of 285 kg N/fed accompanied with 114 kg 2O ha^{-1} were the most effective in improving yield, quality and nutritional status of sugar beet grown in a sandy calcareous soil.

The present study was carried out to find out NPK requirement that enhanced productivity and quality of sugar beet crop in sandy soil using drip irrigation system.

MATERIALS AND METHODS

Two field experiments were carried out in two successive seasons (2012/2013 and 2013/2014) at Al-Hosein Agricultural district 64 km, Cairo, Alexandria Road Giza Governorate (latitude of 31.14^0 N and longitude of 31.39^0 E) to study the effect of some nitrogen.(N), phosphor (P) and potassium (K) levels on yield and quality of sugar beet crop. Soil samples (0-30 cm depth) were taken before experiments performance . Soil physical and chemical properties of the experimental sit as well as used water were done according to Chapman, and Pratt (1961) and are presented in Tables (1a and 1b).

A Split – split plot design with three replicates was used. The plot area was 21 m^2 (3 m x 7 m), each plot consisted five rows 60 cm apart and 7 m in length. The main plots were devoted to nitrogen fertilizer treatments at rates of 80 and 100 kg N/fed. Nitrogen fertilizer was added as ammonium nitrate (33.5 % N) in eight equal doses the 1st one after thinning. Phosphorus treatments were allocated in the sub plots phosphorus treatments of Phosphoric acid (P_2O_5) 80% were allocated in the sub plot at rates of 16, 32 and 48 %/ fed was added in 4 equal doses after planting. The sub-sub plots occupied with K-fertilizer which was added as potassium sulfate (48% K_2O at levels of 24, 36 and 48 kg K_2O/fed, each rate was added in 4 splits (15-day interval) , the 1st one month from thinning. The other agricultural practices were carried out in the same manner prevailing in the region. Seeds of multi germ sugar beet variety viz. Pleno were sown in hills 25 cm apart.

Table 1a: Some chemical properties of the used water in both seasons

Seasons	p^H	EC (ds/m)	E.C (ppm)	S.A.R	R.S.C	S.S.P%	Soluble anions (meq /l)				Soluble cations (meq /l)			
							CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^+	K^+
2012/2013	6.9	5.53	3539.2	7.23	-27.8	47.8	-	2.2	44	12.37	20	10	28	0.57
2013/2014	7.1	5.85	3656.3	8.2	-30.1	49.6	-	2.2	41	12.22	22	10	30	0.78

Table (1b). Soil chemical properties of the experimental sites in both seasons

Seasons	EC (ds/m)	p^H	Ca Co_3 (%)	Soluble anions (meq /l)				Soluble cations (meq /l)				Macro elements (ppm)			Micro elements (ppm)			
				CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^+	K^+	N	P	K	Fe	Cu	Zn	Mn
2012/13	0.90	7.9	4	-	1	2	6.45	4	2	3.2	0.25	10	13	88	0.98	0.08	0.24	1.2
2013/14	0.94	8.1	4	-	1	2	6.65	4	2	3.3	0.22	8	12	80	0.99	0.06	0.22	1.6

Sowing took place in 10 and 15 November, in both seasons, respectively. Plants were thinned to one plant per hill after 40 days from planting (at 4-6 leaf stage).

At harvest (195 days from sowing), the middle four guarded rows were harvested topped and cleaned and weighed to determine the following parameters per fed.

1- Root and top yields /fed
2- A sample of 100 g. fresh weight of leaves and roots were dried at 70°C for 3 days to determine their dry weight.

A sample of 25 kg of roots was taken at random from each plot and sent to the Beet Laboratory at Delta Sugar Factory to determine the following juice quality:

1- Sucrose percentage was determined according as described by Le Docte (1927).
2- Potassium and sodium contents were determined using flame photometer according and Brown and lilliland (1964), and α-amino-N (expressed as mill equivalents/100 g of beet) was determined according to Reinefeld *et al* (1974) *et al.* (1962).
3- Purity percentage was calculated according to the following formula:
   Purity %= [(99.36) – 14.27 (V_1+V_2+V_3)/V_4] (Devillers, 1988). Where:
   V_1 = Sodium as meq /L,
   V_2 = Potassium as meq /L,
   V_3 = α-amino-N as meq /L and
   V_4 = Sucrose %
4- Theoretical sugar yield ton/fed was calculated by multiplying root yield ton/fed by sugar %
5- White sugar yield (Extractable sugar yield) ton/fed was calculated by multiplying root yield (ton/fed) by sugar extractable % which was determined according to the equation described by Reinfeld *et al.* (1974).
   Sugar extractable% $=V_4-[(V_1+V_2)\,0.343+V_3X0.094+0.29]$.

Statistical analysis:

The statistical analysis was carried out according to procedures out lined by Snedecor and Cochran (1981). Means were compared using Duncan's Multiple Range Test (Waller and Duncan, 1955).

RESULTS AND DISCUSSION

The target of this work aimed to increase sugar beet yield through enriching the soil fertility by the application of NPK. So, the obtained results included the effect of different levels of NPK on sugar beet yield, yield components and NPK uptake in top and root of sugar beet.

1- leaves and roots fresh weight :

Results given in Table (2) showed that neither leaves fresh weight /plant nor tops yield of sugar beet crop responded to the increase of nitrogen application, however, it could be noted a distinct and significant response in root fresh /plant as well as root fresh yield, where increasing N- application from 80 to 100 kg. N/fed. raised the values of root fresh yield by 10.15 % and 11.54 % in the 1st and 2nd seasons respectively. The increase in root yield in both growing seasons is mainly due to the increase in the values of the individual root fresh weight as it shown in the Table (2). The positive influence of nitrogen on root yield had been reported by Witold *et al.*, 2012 .

Table (2): Fresh weight of leaves and roots properties as affected by NPK-fertilizationIn the two seasons

Treatment	fresh weight (g\plant)				fresh yield (ton\fed.)			
	Leaves		Root		Tops		Root	
	2012\13	2013\14	2012\13	2013\14	2012\13	2013\14	2012\13	2013\14
Kg.N/Fedd.								
80	237	223	1200 b	1093 b	6.338	6.400	31.528 b	28.601b
100	262	243	1310a	1217 a	6.878	5.701	34.393 a	31.911 a
F – Test	NS	NS	**	**	NS	NS	**	*
Kg. P_2O_5/fed.								
16	263 a	244 a	1264	1170	6.629 a	6.442 a	33.241	30.7
32	276 a	260 a	1180	1106	7.378 a	6.936 a	30.978	29.0
48	210 b	194 b	1321	1189	5.518 b	5.011 b	34.663	31.1
F – Test	**	**	NS	NS	**	**	NS	NS
kg.K_2O/fed								
24	254 a	222 b	1271	1160	6.693 a	5.801 b	33.408	29.0
36	271 a	252 a	1275	1184	7.529 a	6.714 a	33.488	31.1
48	224 b	224 b	1219	1175	5.872 b	5.811 b	31.986	30.8
F – Test	**	*	NS	NS	**	**	NS	NS
Interaction:								
N x P	*	NS	*	NS	**	NS	**	NS
N x K	**	*	NS	Ns	**	*	NS	NS
P x K	NS	NS	NS	NS	NS	NS	NS	NS
N x P x K	*	**	NS	*	NS	**	Ns	**

Data in Table (2) cleared that leaves fresh weight / plant and tops yield were significantly decreased by increase levels of phosphorus in the two seasons. The lowest and the middle levels of phosphorus over passed the highest one in this respect , however, the difference between the lowest and the middle levels of phosphorus was not enough to reach the level of significance. This result is not in coincide with those mentioned by Marinkovic *et al.*, 2008

Concerning of the effect ofpotassium fertilization on fresh weight of leaves and roots properties , data in Table (2) cleared that adding 48kg. K_2O/fed. recorded the highest individual leaves and root fresh weight as well as tops and root fresh yield ,however, these effects were significant for leaves fresh weight/plant and tops fresh yield in both seasons.

A speculative view to the results illustrated in Table (2) it could be deduce that root properties whether in the level of the individual plant and/or on the level of root yield attained a high profit from nitrogen element ,on the contrary the profitability level of leaves and tops yield was negligible. Opposite results were found for the influence of phosphorus and potassium elements , where they were more profit for leaves fresh weight/plant as well as tops yield. This finding was fairly true in both seasons.

2- Dry weight of leaves and roots properties:

The results in Table (3) pointed out that leaves and root dry weight/plant as well as root dry yield of sugar beet was significantly increased by increase nitrogen levels in the 2nd season only, and the lower nitrogen dose attained the highest significant values of these traits . Once more, the influence of nitrogen on tops dry yield was insignificantly in both growing seasons.

Regarding the effect of phosphorus fertilizer on dry weight of leaves and roots properties, the results obtained in Table (3) indicted to leaves and root dry weighs/plant were significantly decreased by the examined doses of P-treatment , fertigate sugar beet plants by the lowest dose *i,e.*16 kg P_2O_5 recorded the highest values of both traits ,however, the differences between phosphorus levels was not enough to reach the level of significance with respect to its effect whether on root dry weight/plant or on root dry yield in both seasons.

Neither root dry weight/plant nor root dry yield was significantly responded to the application levels of potassium fertilization in both season, meanwhile, leaves dry weight/plant in the 1st season and top dry yield in both season responded to potassium fertilizer. Application of 36 kg K_2 O/fed attained the highest values of both characteristics.

Table (3): Dry weight of leaves and roots per plant and per fed. as affected by NPK-fertilization in the two seasons

Treatments	Leaves dry weight (g\plant)		Root dry weight (g\plant)		Tops dry yield (ton\fed.)		Root dry yield (ton\fed.)	
	2012\13	2013\14	2012\13	2013\14	2012\13	2013\14	2012\13	2013\14
Kg.N/fed.								
80	43.4	43.7 a	320	323 a	1.166	1.101	8.4	8.3 a
100	42.4	35.9 b	323	270 b	1.112	1.004	8.5	7.1 b
F – Test	NS	*	NS	**	NS	NS	NS	**
Kg.P_2O_5/fed								
16	51.2 a	48.6 a	349	320	1.353 a	1.301 a	9.2	8.4
32	46.4 a	42.8 a	300	282	1.245 a	1.100 a	7.9	7.2
48	31.2 b	28.1 b	316	289	0.819 b	0.700 b	8.3	7.5
F – Test	**	**	NS	NS	**	**	NS	NS
Kg.K_2O/fed								
24	43.3 a	38.4	314	271	1.142 b	1.001 b	8.3	7.1
36	47.8 a	43.9	331	303	1.292 a	1.200 a	8.7	7.8
48	37.4 b	37.2	320	317	0.984 b	1.002 b	8.4	8.2
F – Test	**	NS	NS	NS	**	*	NS	NS
Interaction								
N x P	NS	NS	**	NS	NS	NS	**	*
N x K	NS	NS	NS	Ns	NS	NS	NS	NS
P x K	NS	NS	NS	NS	NS	NS	NS	NS
N x P x K	NS	NS	NS	NS	NS	NS	Ns	Ns

3- Juice Impurities :

The results in Table (4) indicate the influence of NPK- level on juice impurities of sugar beet. Results given revealed that nitrogen fertilizer significantly effected on sodium and α-amino nitrogen percentages in both seasons. This influence differed from season to season ,as the increasing in N-level increased the percent of sodium and α-amino nitrogen increased in the 1st season , an opposite results were shown in the 2nd season. This response differences may be due to the somewhat differences in soil chemical properties of the experimental sites in both seasons (Table 1-b).

Once more the differences between N-fertilizer were not enough to reach the level of significant with respect to its effect on potassium percentage in both seasons. Also ,neither phosphorus nor potassium levels had a significant influence on the various juice impurities of sugar beet roots in both seasons.

Table (4): Juice impurities in of sugar beet as affected by NPK- fertilization in the two season

Treatments	Potassium mill equivalents/100 g		Sodium mill equivalents/100 g		α-amino nitrogen mill equivalents/100 g	
	2012\13	2013\14	2012\13	2013\14	2012\13	2013\14
Kg.N/fed						
80	5.2	4.6	1.8 b	2.0 a	3.3 b	5.6 a
100	5.1	4.7	2.6 a	1.4 b	3.9 a	4.7 b
F – Test	NS	NS	**	**	**	*
Kg.p_2O_5/fed						
16	5.2	4.6	2.3	1.6	3.7	5.1
32	5.1	4.6	2.1	1.8	3.6	4.9
48	5.0	4.7	2.2	1.7	3.7	4.9
F – Test	NS	NS	NS	NS	NS	NS
Kg.K_2O/fed						
24	5.1	4.6	2.2	1.5	3.5	5.3
36	5.2	4.6	2.2	1.6	3.6	4.6
48	5.1	4.8	2.1	1.9	3.7	5.2
F – Test	NS	NS	NS	NS	NS	NS
Interaction:						
N x P	NS	NS	NS	NS	NS	NS
N x K	NS	NS	NS	NS	NS	NS
P x K	NS	NS	NS	NS	NS	NS
N x P x K	NS	NS	NS	NS	NS	NS

4- Juice quality and sugar yield:

Data presented in Table (5) pointed out that except theoretical sugar yield, juice quality in terms of sucrose %, purity % and white sugar % were significantly affected by the examined level of nitrogen fertilizer levels. It seems that the low level of nitrogen fertilizer *i.e.* 80 kg.N/fed. under drip irrigation system was enough to create a distinct effect on juice quality. This finding was completely true in both growing seasons. However, this result was completely on the contrary for root yield (Table 3) where the highest root yield was recorded with the highest dose of nitrogen(100 kg.N/fed.). Effect of nitrogen fertilizer on juice quality and sugar yield had been reported by Attia, 2004.

Concerning phosphorus influence on juice quality and sugar ,the collected data in Table (5) showed that except sucrose percentage in the 1st season ,the others juice quality and sugar yield were not significantly responded to the increase of phosphorus levels.

Table (5): Juice quality and sugar yield as affected by NPK – fertilization in the two seasons

Treatment	Sucrose %		Purity %		White sugar %		Sugar yield (ton\fed.)	
	2012\13	2013\14	2012\13	2013\14	2012\13	2013\14	2012\13	2013\14
Kg.N/fed								
80	18.8 a	21.6 a	84.0 a	86.9 a	15.7 a	19.3 a	4.937	5.601
100	18.2 b	20.3 b	82.1 b	85.2 b	14.5 b	17.5 b	4.916	5.500
F – Test	*	**	*	**	**	**	NS	NS
Kg.p_2O_5/fed								
16	18.8 a	21.1	82.8	86.1	15.3	18.6	5.052	5.702
32	18.7 a	21.0	83.8	86.4	15.4	18.4	4.729	5.311
48	17.9 b	20.8	82.5	85.6	14.6	18.3	4.998	5.610
F – Test	**	NS	NS	NS	NS	NS	NS	NS
Kg.K_2O/fed								
24	18.3 b	21.3	83.4	86.8	15.0 ab	19.0	4.967	5.521
36	18.1 b	20.5	82.4	86.5	14.7 b	18.0	4.876	5.501
48	18.9 a	21.0	83.3	85.2	15.6 a	18.2	4.936	5.600
F – Test	*	NS	NS	NS	*	NS	NS	NS
Interaction:								
N x P	**	NS	**	NS	**	NS	NS	NS
N x K	NS	NS	NS	NS	NS	NS	NS	*
P x K	NS	NS	NS	NS	NS	NS	NS	NS
N x P x K	NS	NS	**	NS	NS	NS	NS	*

As for , potassium fertilizer influence on juice purity and sugar yield/fed. .results given in Table (5) appeared that sucrose % and white sugar % in the 1st season only attained a positive response to the increase in the applied dose of potassium fertilizer, mean while the other juice traits criteria was insignificantly affected by K- application level.. It could be noted that ,despite of the effective role of potassium mainly on juice quality and sugar accumulation in sugar beet roots, the applied level did not appear a significant effect on purity % and sugar yield in both seasons and sucrose % and white sugar % in the 2nd season. This observation may be due to that the used level of potassium was not enough to appear the distinct role of potassium on juice quality especially under the low potassium content in the soil as it shown in soil analysis (Table1-a)

Interactions

Data shown in Table (6) appeared that top and root fresh weight/plant was significantly affected by the interaction between nitrogen and phosphorus fertilizer treatments . It could be noted that both of top and root fresh weight were resemble each other with respect to their response to the interaction between nitrogen and phosphorus treatments, the low nitrogen level , the low or the middle level of phosphorus attained the highest values of both traits, meanwhile with the high nitrogen level the highest value of top fresh weight was recorded with 16 kg.P_2O_5/Fed. , where as the highest root fresh weight was found with 16 or 32 kg.P_2O_5/Fed. This finding may indicate that sugar beet root may be need to higher combination from NP rather than top fresh weight to attain higher value.

Table (7) illustrate the interaction effect between potassium and nitrogen treatments on top fresh weight. Results obtained pointed out that the positive response of the interaction was there is no clear cut trend could be deduce due to the interaction effect in both season , whatever , the highest top fresh weight was recorded with the higher nitrogen dose and 24 kg K_2O_5/fed .in both seasons.

Results given in Table (8) cleared that root dry weight/plant in the 1st season and root dry yield in the two seasons significantly affected by the interaction between nitrogen and phosphorus fertilizer treatments. It is clearly show under the low nitrogen level (80 kg N,/fed.), increasing the applied dose of phosphorus almost raised the values of root dry weight /plant as well as root dry yield ,However, under the high nitrogen level (100 kg/N/fed.),the lowest level of phosphorus was enough to produce the highest values of root dry weight/plant in the 1st season and the highest root dry yield in both seasons. This result may be due to the balance effect between the two elements to attain the best reaction.

Table (6): Top and root fresh weight (g/plant) as affected by the interaction between nitrogen and phosphorus levels in 2012/2013

Treatment	2012/2013					
	Top weight (g\plant)			Root weight (g\plant)		
	kg.P_2O_5/Fed			kg.P_2O_5/Fed		
Kg .N/fed	16	32	48	16	32	48
80	224 bc	283 a	204 c	1110 b	1264 ab	1225 ab
100	301 a	268 ab	217 c	1417 a	1416 a	1097 b

Table (7): Top weight (g\plant) as affected by the interaction between nitrogen and potassium fertilizer treatments in the two season

Kg.N/fed	Top weight (g\plant)					
	2012/2013			2013/2014		
	K_2O_5/fed .			K_2O_5/fed .		
	24	36	48	24	36	48
80	264 b	237 bc	209 c	243 b	274 a	211 bc
100	244 bc	304 a	238 bc	190 c	271 a	207 bc

Table (8): Root dry weight (g/plant) and root dry yield (ton\fed.) as affected by the interaction between nitrogen and phosphorus fertilizer in the two seasons

Kg. N/fed	Root dry weight (g/plant)			Root dry yield (ton\fed.)					
	2012/2013			2012/2013			2013/2014		
	P_2O_5/Fed			P_2O_5/Fed			P_2O_5/Fed		
	16	32	48	16	32	48	16	32	48
80	287 ab	347 ab	327 ab	7.563ab	9.113ab	8.576ab	8.133 ab	8.238 ab	8.613 a
100	411 a	253 b	305 ab	10.780a	6.644 b	8.019ab	8.702 a	6.224 C	6.364 bc

Results given in Table (9) showed that juice quality of sugar beet roots was significantly affected by the interaction between nitrogen and phosphorus fertilizer treatments. It is obviously shown that the combination between 80 kg. N/fed. and the three levels of phosphorus almost over passed significantly the combination between 100 kg.N/fed. and these various phosphorus levels with respect to their influence on juice quality in terms of sucrose %, white sugar % and purity %. At the meantime , the highest values of these traits were recorded with the combination between 80 kg. N.8fed. and 16 P_2O_5/Fed.

Data obtained in Table (10) show the 2nd order interaction between nitrogen, phosphorus and potassium fertilizers and its effect on top weight /plant in the two seasons and root fresh weight/plant in the 2nd season. The results obtained revealed that both traits were significantly affected by this interaction. The most effectiveness combination between the studied factors on top fresh weight/plant was that between 100 kg.N./fed.,16kg.P_2O_5/fed. and 36 K_2O_5/fed. However, with respect to root fresh weight/plant ,the effectiveness combination on this trait was consisted of 80 kg. N./fed., 36 kg. P_2O_5/fed. and 48 K_2O_5/fed. It could be noted that this observation indicates the need for the highest level of potassium to attain the heaviest root fresh weight.This observation may be due to the important role of potassium in metabolic substances accumulation which in turn was reflected on root fresh weight.

Table (9): Juice quality as affected by the interaction between nitrogen and phosphorus fertilizer in 2012/2013 season

Kg. N/fed	2012/2013								
	Sucrose %			White sugar %			Purity %		
	P_2O_5/Fed			P_2O_5/Fed			P_2O_5/Fed		
	16	32	48	16	32	48	16	32	48
80	19.0 a	18.1 b	18.2 b	16.0 a	15.3 ab	15.8 a	84.2 a	83.5 a	84.3 a
100	18.1 b	18.0 b	17.1 c	14.6 b	15.4 ab	13.4 c	81.3 b	82.1 b	82.8 b

Table (10): Top and root fresh weight (g/plant) as affected by the interaction among NPK treatments in the two seasons

Kg. N/fed	Kg. P_2O_5 /Fed	Top weight (g/plant)						Root weight(g\plant)		
		2012/2013			2013/2014			2013/2014		
		kg. K_2O/fed			kg. K_2O/fed			kg. K_2O/fed		
		24	36	48	24	36	48	24	36	48
80	16	265 b-f	224 d-g	184 g	303 ab	218 c-h	208 d-h	1330 ab	992 cd	1236 abc
	32	312 b	303 bc	236 c-g	269 a-e	292 abc	263 a-f	1211 a-d	1233 abc	1173 a-d
	48	217 d-g	185 g	209 d-g	186 fgh	252 a-g	192 e-h	1098 bcd	1440 a	1242 abc
100	16	272 bcd	401 a	232 c-g	179 gh	324 a	234 b-g	980 cd	1259 abc	1223 abc
	32	269 b-f	313 b	221 d-g	211 d-h	276 a-d	250 a-g	910 d	1063 bcd	1046 bcd
	48	192 fg	197 efg	261 b-f	182 gh	151 h	198 d-h	1106 bcd	1118 bcd	1129 bcd

Data in Table (11) cleared that sugar yield responded significantly to the 2[nd] order interaction of 80 kg. N./fed., 16 kg.P_2O_5/fed. and 24 K_2O/fed. Whereas ,the highest purity % was recorded with 100 kg. N./fed., 32 kg.P_2O_5/fed. and 24 K_2O/fed. At the meantime there was no significant difference between this combination and that which attained the highest sugar yield. So it could be considered that the combination of 80 kg. N./fed., 16 kg.P_2O_5/fed. and 24 K_2O/fed. to produce the highest sugar yield/fed. with less amount of NPK fertilizer requirement.

Table (12): Top and root yields as affected by the interaction between nitrogen and phosphorus levels in 2012/2013 season

Nitrogen kg./fed. (N)	Top yield (ton/fed)			Root yield (ton/fed)		
	kg.P_2O_5/Fed			kg.P_2O_5/Fed		
	16	32	48	16	32	48
80	5.946 b	7.726 a	5.343 b	29.291 b	33.160 ab	32.131 ab
100	7,911 a	7.029 a	5.694 b	37.190 a	28.790 b	37.200 a

Table (13): Top yields as by the interaction between nitrogen and potassium levels in the two seasons

Kg.N /fed.	Top yield (ton/fed)					
	2012/2013			2013/2014		
	kg. K_2O/fed			kg. K_2O/fed		
	24	36	48	24	36	48
80	6.546 b	6.974 a	5.496 b	6.675 ab	6.918 a	5.791 bc
100	6.413 ab	7.973 a	6.249 b	5.817 bc	6.580 ab	4.996 c

Table (14): Top and root yield/fed. as affected by the interaction among NPK treatments 2013/2014 seasons

kg.	kg.P_2O_5	Top yield (ton/fed)			Root yield (ton/fed)		
		kg.K_2O/fed			kg.K_2O/fed		
		24	36	48	24	36	48
80	16	8.058 ab	5.821 c-f	5.442 c-f	35.280 ab	26.161 cd	32.454 abc
	32	7.070 abc	8.317 ab	6.889 a-d	31.791 a-d	32.373 abc	30.782 a-d
	48	4.896 ef	6.615 a-e	5.041 def	28.821 bcd	37.782 a	32.541 abc
100	16	4.692 ef	8.507 a	6.126 cde	25.721 cd	33.044 abc	32.091 abc
	32	5.529 c-f	7.254 abc	6.559 b-e	23.901 d	27.901 bcd	27.461 bcd
	48	4.768 ef	3.980 f	4.766 ef	29.021 bcd	29.351 bcd	29.691 bcd

General discussion:

The increases in yield and its components as a result of increasing NPK certain levels can be ascribed to the role of nitrogen in improving vegetative growth through enhancing leaf initiation, greenness and duration of the leaf canopy as well as meristematic activity which contribute to the increases in number of cells in addition to cell enlargement. Moreover, nitrogen helps plants to more nutrients uptake, enhancing net assimilation rate and hence activating accumulation of photosynthates , from leaves to developing roots which in turn increase root length, diameter, root fresh weight and finally root and sugar yields per unit area (Moore et *al* ,1999) . Also, the role of phosphorus in energy transfer within the plants and in maintaining the structural integrity of the plant cell membranes as well as carbohydrate assimilation could improved plant growth, which was reflected in increasing root weight (Sims and Smith ,2001). Beside, the role of potassium in building up metabolites and activating starch syntheses enzymes and carbohydrates accumulation from the source (leaves) to the developing roots (sink) cannot be neglected in this respect Moore et *al* (1999). Increasing potassium fertilizer level significantly increased root weight and dimensions, sucrose and purity percentages,

These results ascertain the view that a certain proper combination should be maintained between the three nutrients under study in order to enhance the groth of sugar beet plants through a harmony between shoots (source) and roots (sink). Additional of 80 Kg. N , 16 kg P_2O_5 and 24 kg.K_2O/fed. was the proper combination which achieved this view and maximized

Sugar yield/fed. These results are in coincidence with those stated by Abdel-Motagally and Attia (2009).

Economical evaluation:

Data in Table (15) illustrate that root yield/fed., total costs &revenue and net income per Feddan of sugar beet cultivated under drip irrigation system in sandy soil at *Al-Hosein Agricultural Society at 64 km, Cairo, Alexandria Road, Giza Governorate (latitude of 31.14^0 N and longitude of 31.39^0 E)*

Table (15): Total costs , revenue and net income of root yield /fed. under the studied NPK treatments in the two seasons.

Kg./fed			Root yield Tons/fed.			Total L.E/fed.		Net income L.E/fed.
N	P_2O_5	K_2O	2012/2013	2013/2014	Mean	costs	Revenue*	
80	16	24	38.89	35.28	37.08	3366	14090	10724
		36	27.33	26.16	25.24	3538	9591	6053
		48	29.64	32.45	31.04	3708	11795	8087
	32	24	36.45	31.79	34.12	3186	12965	9779
		36	34.55	32.37	33.46	3556	12714	9158
		48	28.48	30.78	29.63	3726	11259	7533
	48	24	33.12	28.82	30.79	3404	11700	8296
		36	28.14	37.78	32.96	3574	12524	8950
		48	35.12	32.54	33.78	3744	12836	9092
100	16	24	34.07	25.72	29.89	3526	11358	7832
		36	41.03	33.04	37.03	3896	14071	10175
		48	31.50	32.09	31.80	3868	12084	8216
	32	24	30.37	23.90	27.14	3346	10312	6967
		36	31.79	27.90	29.85	3716	11343	7627
		48	24.20	27.46	25.83	3886	9815	5929
	48	24	30.54	29.02	29.73	3564	11297	7733
		36	38.06	29.35	32.21	3734	12239	8505
		48	42.10	29.69	30.89	3904	11738	7834

• : Price of ton=L.E. 380

Results obtained pointed out to that the productivity of such soil ranged between 25.24 ton/fed. to 37.08 ton /fed. ,where as the total costs of the various treatments ranged between L.E.3186 to L.E.3896 (The differences based upon the values of NPK treatments). Data given in Table (15) revealed that the recommended package that produced the highest profit (L.E. 10724/ fed.) was to grow sugar beet plants under the fertilizer combination of 80 N ,16 P_2O_5 and 24 K_2O Kg./fed in addition to the common agricultural practices as mentioned in the experiment.

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احتياجات بنجر السكر من النيتروجين و الفوسفور والبوتاسيوم تحت ظروف الأراضى الرملية

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الملخص العربى

اجريت تجربتان حقليتان فى الأراضى الرمليةفى موسمين متتاليين2013/2012 و 2014/2013 فى جمعية الحسين الزراعية عند الكيلو 64 من طريق القاهرة الأسكندرية الصحراوى= محافظة الجيزة(31.14 درجة شمالاً و31.39 درجة شرقاً)لدراسة الإحتياجات السمادية اللازمة من النيتروجين والفوسفور والبوتاسيوم واثرها على انتاجية وجودة محصول بنجر السكر فى الأراضى الرملية. اشتملت التجربة على 18 معاملة هى التوافق بين مستويين من النيتروجينى(80 و 100 كجم ن/فدان) وثلاث مستويات من الفوسفور(16،32 و 48 كجم فو2 أ5

/فدان و ثلاث مستويات من البوتاسيوم (24 و 36 و48 كجم بو2أ5 /فدان) وتشير أهم النتائج المتحصل عليها إلى:

1- أدت زيادة النيتروجين من 80 إلى 100 كجم ن / فدان إلى زيادة متوسطات الوزن الطازج لمحصول الجذور بنحو 10.15 % و 11.54 % فى الموسم لأول والثانى على الترتيب ، وايضاً تأثر سلبياً كل من الوزن الطازج/النبات ومحصول العرش معنوياً بزيادة مستوى الفوسفورعن 32 كجم فو2أ5 /فدان ، كما سجلت إضافة 48 كجم بو2أ5 /فدان أعلى زيادة فى الوزن الطازج للجذور والأوراق للنباتات الفردية وايضاً الوزن الطازج لمحصول العرش والجذور.

2- تأثرت صفات الجودة(سكروز %، النقاوة % و السكر الأبيض %) معنوياً وسلبياً بالمعدلات المختبرة من النيتروجين وقد اعطى المعدل المنخفض من السماد النيتروجينى(80 كجم ن / فدان) تحت نظام الرى بالتنقيط افضل تأثيرعلى صفات الجودة، ولم تتأثر صفات الجودة ومحصول السكر /فدان بالمستويات المختبرة من السماد الفوسفاتى ، بينما استجاب كل من السكروز % والسكر الأبيض % إيجابياً ومعنوياً للجرعات المضافة من السماد البوتاسى فى الموسم الأول فقط.

3- ويعتبر التوافق بين 80 كجم نيتروجين ، 16 كجم فو2أ5 /فدان و 24 كجم بو2أ5 /فدان التوافق الأنسب للجصول على أعلى محصول من السكر مع أقل كمية من التسميد بالعناصر الثلاثة.وقد تحققت اعلى إنتاجية من محصول الجذور(37.782 طن/فدان) وذلك بالتوافق بين 80 كجم ن/فدان ، 48 كجم فو2أ5 /فدان و 36 كجم بو2أ5 /فدان . وإجمالاً وتأسيساً على ضرورة الإضافة المتوازنة من العناصر الغذائية خاصة فى الأراضى الرملية إلى جانب الإرتفاع المستمر فى اسعارالأسمدة يمكن التوصية باضافة 80 كجم نيتروجين ، 16 كجم فو2أ5 /فدان و 24 كجم بو2أ5 /فدان. وقد اشارت نتائج التحليل الإقتصادى للتكاليف والعائد أن هذه هى أفضل حزمة توصيات من الأسمدة الثلاثة.