J. Agric. Sci. Mansoura Univ., 31 (8): 4885 - 4899, 2006

EFFECT OF POTASSIUM AND NITROGEN FERTILIZER ON YIELD AND QUALITY OF SUGAR BEET (*Beta vulgaris*, L.) GROWN AT NORTH DELTA.

El-Sheref, E. El. M.
Dept. of Agronomy, Faculty of Agric. at Kafr El-Sheikh, Tanta University

ABSTRACT

Two field experiments were carried out at the Experimental Station, Fac. of Agric., Kafr El-Sheikh, Tanta Univ., during the successive seasons of 2002/2003 and 2003/2004 to study the response of sugar beet yield and quality to potassium and nitrogen fertilization rates under North Delta conditions. The split plot design with three replicates was used. The main plots were randomly assigned to the three potassium fertilizer rates (24, 36 and 48 kg K_2O/fad), whereas the three nitrogen levels (80, 100 and 120 Kg N/fad) were arranged in the sub-plots.

The obtained results could be summarized as follows:

1. On the average root, top and sugar yields/fad were increased by increasing K rate up to 48 kg K_2O/fad, while the soluble non-sugar content, gross and white sugar, loss sugar as well as juice purity were not affected by K application.
2. Increasing nitrogen rate up to 120 kg N/fad markedly increased diameter, weight of foliage and roots as well as top, root and sugar yields/fad.
3. Generally, it can be concluded that the addition of 48 kg K_2O with 120 kg N/fad could be a recommended for raising sugar beet yield and quality under the conditions of North Delta district.

INTRODUCTION

Sugar beet (*Beta vulgaris*, L.) is one of the most important sugar crops in the world. The Egyptian Government encourages sugar beet growers to increase the cultivated area of it for decreasing the gap between sugar production and consumption. It is the major second crop area after rice in North Delta. The crop gives the grower of low fertility soils good profitable income.

Sugar beet is classified as a plant that need high potassium requirements where more of it is absorbed by sugar beet than any other nutrients element (Johnson *et al.*, 1971). Potassium fertilization also became important for sugar beet particularly in Northern Delta soils (Hegazy *et al.*, 1992). potassium is greatly required by sugar beet. It is very mobile in plant tissues and was found through out the plant. It is important to photosynthesis, and sugar produced relies on potassium for movement to the storage tissues in the root. At harvest, plants given potassium has significantly greater sugar percentage than those given none. Potassium also improves performance by increasing leaf area in growth stages (Cooke and Scott, 1993). Potassium uptake depend upon N uptake, plant growth, availability of K, year and genotype (Carter, 1986a). Many investigators reported that root length, root fresh weight, sucrose percentage, top, root and sugar yields (ton/fad.) were increased significantly with increasing potassium fertilizer rates (Beringer *et al.*, 1986; Zalat, 1986; Sayed, 1988; Edris *et al.*, 1992; Hegazy *et al.*, 1992; Sobh *et al.*, 1992; Kandil *et al.*, 1993; Abd El-Wahab *et al.*, 1996; El-Ramady, 1997; El-Hawary, 1999; Omar *et al.*, 2002 and Hilal 2005).

Finally, after review of numerous literatures about the role of potassium in sugar beet nutrition and its effects on the yield and quality, it could be summarize the functions of potassium in plants into six areas according to Samwel *et al.* (1990) enzyme activation, water relations, energy relations, translocation of assimilates, Nitrogen uptake and protein synthesis and starch synthesis.

Fertilization is the most important limiting factor for sugar beet production under Egyptian soil conditions. In most sugar beet growing regions, nitrogen is the most important fertilizer element. This is because nitrogen is usually in short supply in soils under continuous cropping. Nitrogen is more efficient than most elements for maximum yield and must be given as fertilizer, to increase yield greatly but the crop quality might be is declined, particularly with large dressings. The amount of nitrogen fertilizer needed by sugar beet has been the subject of many experiments in many sugar beet growing countries.

Winter (1986) in Texas, pointed out that nitrogen management is one of the most difficult production problems for sugar beet growers. The ideal N regime for sugar beet provides adequate N early in the growing season for high root yield followed by a 4 to 9 week period of N deficiency prior to harvest to maximize sucrose content.

The primary effect of nitrogen fertilizer is on root and top dry matter production, much of which is eventually stored in form of sugar. The effect on sugar percentage results from increasing water retention by the tap root. The drop in juice purity largely reflects increasing concentration of amino compounds caused by excessive uptake of nitrate late in the season (Follett, 1991). In Egypt many investigations cleared that applying N at level of 90-110 Kg/fad exhibited the highest root quality, technological parameters, root and sugar yields (ton/fad) and minimized sugar lost to molasses. Whereas further increases in N rate decreased sucrose, purity and recoverable sugar percentages. (Ramadan, 1997; Azzazy, 1998; El-Sheref, 1998; El-Hawary, 1999; Hassanin and Elayan, 2000; Hilal, 2000; Moustafa *et al.*, 2000; Saif, 2000; El-Harriri and Gohaarha, 2001; Moustafa and Darwish, 2001; Abo El-Wafa, 2002 and Hilal, 2005).

The aim of the present investigation was to study the effect of potassium and nitrogen rates on yield and its attributes of sugar beet plants as well as it's juice quality.

MATERIALS AND METHODS

Two series of field experiments were carried out at the Experimental Station, Faculty of Agriculture, Kafr El-Sheikh, Tanta University during 2002/2003 and 2003/2004 growing seasons, to study the response of sugar beet yield and quality to potassium and nitrogen fertilization under North Delta conditions.

Soil structure and chemical analysis were taken from 0-30cm depth in the experimental sites before soil preparation (mean of two seasons). Mechanical analysis it's (Sand 13.86%, Silt 22.54% and Clay 60.91%). The soil type was clay texture. While, chemical analysis it's (pH 8.30, Organic matter 1.99%, Soil salts (Ec, ds/m) 2.82, Available N (ppm) 22.62, Available P (ppm) 7.05 and Available K (ppm) 278.16).

The preceding summer crop was rice in both seasons. Sugar beet was sown on 20/10/2002 and 25/10/2003 seasons. Soils were fertilized with 30 kg P_2O_5/fad in the form of calcium super phosphate (15.5% P_2O_5) during soil preparation.

Seeds of multigerm sugar beet cultivar "Karolla" 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. Other cultural practices were done as recommended.

A split plot design with three replications was used in both seasons. The experiment included 9 treatments. The three potassium fertilizer rates (24, 36 and 48 kg K_2O/fad) were distributed at random in the main plots, whereas the three nitrogen fertilizers levels (80, 100 and 120 kg N/fad) were allocated randomly in the sub plots. The sub plot area was 25.2 m^2 and included six ridges, 7 m long 60 cm apart and 20 cm between hills. The outer two ridges were considered as belt or band. The central ridges were kept to determine yield and yield attributes. Potassium in form of potassium sulphate (48% K_2O) and nitrogen fertilizers in form of urea (46.5% N) were applied in two equal doses, after thinning and 25 days later.

The collected data in both seasons involved the following traits:

At maturity (210 days from sowing), a central area of 16.8m^2 from each plot were harvested at both seasons, to estimate the following characters:

Yield and its attributes :

1. Root length (cm).
2. Root diameter (cm).
3. Root weight kg/plant.
4. Foliage fresh weight/plant (kg).
5. Root yield (t/fad).
6. Top yield (t/fad).
7. Gross sugar yield (t/fad) = root yield (t/fad) × gross sugar percentage.
8. White sugar yield (t/fad) = root yield (t/fad) × white sugar percentage

Quality parameters :

All parameters were determined in Delta Sugar Company limited laboratories at El-Hamoul, Kafr El-Sheikh Governorate according to the method of Le-Docte (1927) as described by McGinnus (1971).

The parameters of quality included :

1. Gross sugar %:

Juice sugar content of each treatment was determined by means of an automatic sugar polarimetric according to LeDocte (1927) as described by McGinnus (1971).

2. Extractable white sugar %:

Corrected sugar content (white sugar) of beet was calculated by linking the beet non-sugars K, Na and α-amino (expressed as milliequivalents/100 g of beet) according to Reinefeld *et al.* (1974) as described by Harvey and Dutton (1993) as follows:

$$ZB = Pol - [0.343 (K + Na) + 0.094 \text{ Am N} + 0.29]$$

Where : ZB = Corrected sugar content (% per beet) or extractable white sugar

Pol = Gross sugar %

Am N = α-amino-N determined by the "blue number method"

3. Loss sugar % = gross sugar % - white sugar %.

4. Juice purity percentage.

$$\text{Juice purity \% (QZ)} = \frac{ZB}{Pol} \times 100$$

5. Soluble non-sugar content.

The soluble non-sugars (potassium, sodium and α-amino nitrogen in meq/100 g of beet) in roots were determined by means of an automatic sugar polarimetric.

Statistical analysis :

The data pertaining to various characters were analyzed statistically using Fisher's analysis of variance technique and LSD test was applied at 5% probability level to determine the differences among means the treatments according to Steel and Torrie (1984).

RESULTS AND DISCUSSION

The obtained results of yield and its components as well as sugar quality as influenced by Potassium; Nitrogen and their interactions in 2002/2003 and 2003/2004 seasons could be discussed as follow :

I. Yield and its components :

1. Root length (cm):

Means of root length at harvest as affected by potassium and nitrogen fertilizers during the two growing seasons are presented in Table 1.

Potassium rates had significant effect on root length in both seasons. Application of 24 or 36 kg K_2O/fad resulted in the highest average values (38.07, 39.70 and 34.33, 35.17) of root length in the first and second seasons, respectively. The increases in root length due to increasing leaf area, photosynthesis and translocation as assimilates to storage root for K on plant (Samwel *et al.*, 1990 and Cooke and Scott, 1993). Similar results were obtained by Emara (1990) and Omar (1998). On the other hand Sarhan (1998) reported that potassium fertilizer had insignificant effect on root length.

Concerning the effect of N fertilizer, on root length, results revealed significant effect. In general 100 and 120 kg N/fad gave the tallest roots in both seasons. The increases in root length may be due to cell division and elongation for the promotion N on meristimic activity of plant. Similar results were reported by Azzazy (1998), Sultan *et al.* (1999) and Hilal (2000).

The interaction effect between potassium and nitrogen rates had highly significant effect on root length in both seasons. The highest root length was obtained from adding 100 or 120 kg N/fad with 24 or 36 kg K_2O/fad in both seasons, Table (1a).

2. Root diameter (cm):

The effect of potassium and nitrogen fertilizer on root diameter during the first and second seasons are presented in Table (1).

Potassium fertilizer failed to exert any significant difference in root diameter in the two seasons. Neamet Alla (1991) came to the same conclusion. However, El-Ramady (1997) found that root diameter was significantly increased by increasing potassium rate up to 48 K_2O/fad.

With respect to the effect of Nitrogen fertilizer, data revealed that maximum root diameter for both seasons 14.80 and 13.76 cm were obtained from 120 kg N/fad. Meanwhile, the lowest one was obtained from application of 80 Kg N/fad.

Table 1: Root and top yields and their components of sugar beet as affected by K and N application rates in 2002/2003 and 2003/2004 seasons.

Characters / Treatments	Root length (cm)	Root diameter (cm)	Root weight kg/plant	Foliage fresh weight (kg/plant)	Root yield (t/fad)	Top yield (t/fad)
	2002/2003 season					
Potassium rates (kg K_2O/fad):						
24	38.07	14.00	1.06	0.54	36.83	18.99
36	39.70	13.90	1.13	0.62	39.65	21.72
48	37.07	13.97	1.17	0.68	40.92	23.68
F. test	*	NS	**	**	**	**
LSD	1.50	-	0.01	0.01	0.05	0.09
Nitrogen rates (Kg N/fad) :						
80	36.17	13.10	0.97	0.50	33.97	17.44
100	39.53	14.37	1.15	0.63	40.39	22.30
120	39.13	14.80	1.23	0.76	43.04	24.66
F.test	**	**	**	**	**	**
LSD	1.31	0.25	0.01	0.02	0.21	0.51
Interaction (K xN)	**	**	**	**	**	**
	2003/2004 season					
Potassium rates (kg K_2O/fad):						
24	34.33	13.20	1.10	0.59	38.42	20.50
36	35.17	13.33	1.21	0.67	41.69	23.40
48	34.03	13.30	1.22	0.71	42.67	24.70
F. test	*	NS	**	**	**	**
LSD	0.76	-	0.02	0.03	0.11	0.88
Nitrogen rates (Kg N/fad) :						
80	32.00	12.20	1.06	0.55	36.51	19.31
100	35.20	13.63	1.21	0.69	42.25	24.34
120	36.33	13.76	1.26	0.71	44.03	24.95
F. test	**	**	**	**	**	**
LSD	0.66	0.08	0.03	0.01	0.72	0.38
Interaction (K xN)	**	**	**	**	**	**

In general, significant effects for interaction between K and N fertilizer on root diameter were recorded during both seasons. The broadest root diameter was 14.70 cm and 14.30 cm obtained from 48 K_2O + 100 kg N/fad in the first season and second one, respectively, Table (1a).

Table 1a: Root length and diameter as affected by the interaction between potassium and nitrogen rates in 2002/2003 and 2003/2004 seasons.

Potassium rates (kg K_2O/fad)	Root length (cm)			Root diameter (cm)		
	Nitrogen rates (kg N/fad)					
	80	100	120	80	100	120
	2002/2003 season					
24	35.00	39.00	40.00	13.60	14.40	14.00
36	39.50	39.60	40.00	13.10	13.90	14.70
48	34.00	40.00	39.20	12.60	14.70	14.60
LSD	2.13			0.39		
	2003/2004 season					
24	30.00	35.00	38.00	11.80	13.10	13.80
36	34.50	35.00	36.00	12.70	13.50	13.80
48	31.50	35.60	35.00	12.10	14.30	13.50
LSD	1.07			0.15		

3. Root yield :

Root weight/kg at harvest as well as root yield t/fad as affected by potassium and Nitrogen fertilizer rates are shown in Table 1.

Potassium fertilization had highly significant effect on sugar beet root yield during the two growing seasons. Data presented in Table 1 show that the highest root weight and yield were produced by using 48 K_2O/fad. Such increase in root yield may be attributed to the increase of dry matter, transportion accumulation and to the some extent to the increase of root length and diameter. Also, the role of potassium could be explained through its need as cofactor (enzymes activator) for different enzymes. In addition potassium is needed for vital processes and its beneficial effect in translocation of carbohydrates to the storage organs. Similar reports were found by Emara (1990), Sharief *et al.* (1997), Omar (1998), Selim (1998), Moustafa *et al.* (2000), El-Shahawy (2002) and Omar *et al.* (2002).

Nitrogen rates exerted significant effect on root weight plant as well as root yield t/fad in both season. Root yield was practically increased by increasing nitrogen rates from 80 to 120 Kg N/fad in the tow seasons. Thus, the high nitrogen rate increased root yield through increasing dry matter accumulation and root size as well as root weight. The highest root yields were obtained from 120 kg N/fad (43.04 and 44.03 t/fad) in both seasons, respectively. Similar results were obtained by several workers including Rozbicki *et al.* (1993), Sharief and Eghbal (1994), Toor and Bains (1994), El-Essawy (1996) and Mohamed (2004).

The obtained results indicated that the interaction between K and N-fertilizer significantly affected on root yield (Table 2). The highest root yield was obtained at 48 kg $K_2O \times 120$ kg N (44.72 and 45.20 ton/fad) in both seasons, respectively.

4. Top yield :

Means as foliage fresh weight kg/plant as well as top yield t/fad. as affected by K and N-fertilizer rates are shown in Table 1.

The obtained results show that potassium fertilizer had significant effect on top yields. The highest average values of top yield (23.68 and 24.70

t/fad) were obtained from application of 48 kg K_2O/fad in the first and second seasons, respectively. Wallingford (1980) reported that the important role of potassium on sugar transport and translocation of metabolites the storage organs in plants and its role as co-enzyme and precursor for production of high energy molecules besides the reactions involved in nitrogen uptake, synthesis of protein and starch. Beringer *et al.* (1986) found that plants at high K nutrition are physiologically young and should not be harvested prematurely, as they require longer growing season to realize their yield potential. Similar results were reported by Abd El-Aziz *et al.* (1992), Edris *et al.* (1992), Kandil *et al.* (1993), Abd El-Wahab *et al.* (1996), El-Ramady (1997) and Omar *et al.* (2002).

Table 2. Root and top yields as affected by the interaction between potassium and nitrogen rates in 2002/2003 and 2003/2004 seasons.

Potassium rates (kg K_2O/fad)	Root yield t/fad			Top yield t/fad		
	Nitrogen rates (kg N/fad)					
	80	100	120	80	100	120
	2002/2003 season					
24	31.24	38.10	41.16	13.72	19.11	24.13
36	34.79	40.92	43.24	17.52	23.03	24.62
48	35.89	42.14	44.72	21.07	24.75	25.24
LSD	0.30			0.72		
	2003/2004 season					
24	33.8	39.29	42.90	14.70	23.03	23.77
36	37.98	43.12	43.98	20.21	24.87	25.11
48	38.47	44.35	45.20	23.03	25.11	25.97
LSD	1.02			0.91		

The results indicated significant effects on means of foliage fresh weight/plant and yield/fad at harvest in both seasons due to N-fertilizer rates (Table 1). Data revealed that the highest top yield was (24.66 and 24.95 t/fad) recorded at 120 kg N/fad in the first and second seasons, respectively. This increase may be due to stimulated vegetative growth of sugar beet plants to nitrogen. Thus, reflecting the important role of nitrogen in building up the photosynthetic area of beet plants and more dry matter accumulation. There results are in harmony with those obtained by Sharief and Eghbal (1994), Sultan *et al.* (1999), Hassouna and Hassanein (2000) and Mohamed (2004).

The effect of interaction between potassium and nitrogen rates on top yield per plant as well as per faddan was significant in both seasons (Table 2). The highest top yield was obtained from beets received 48 kg K_2O + 120 kg N/fad, while the lowest one was obtained from 24 Kg $K_2O \times$ 80 kg N/fad. This result indicates the positive relation between either K × N on dry matter accumulation and top yield.

II. Quality parameters :

Beet quality is not a single character which can be presented in a quantitative from by using a single numerical value; it is a combination of all the chemical and physical aspects of beet root which influence processing, or which affect sugar yield or its by-products.

Quality of root juice, i.e. concentration of K, Na and α-amino N, gross sugar %, extractable white sugar %, loss sugar %, juice purity %, sugar yield as well as white sugar yield t/fad as affected by K and N-fertilizers rates are presented in Table 3.

1. Gross sugar yield:

Gross sugar percentage and yield t/fad as affected by potassium and nitrogen fertilizers are presented in Table 3.

With regard to the effect of potassium levels on gross sugar yield, data show that increasing the rate of K-application resulted in an increases in gross sugar yield. The highest average values (7.49 and 8.11 t/fad) were obtained from 48 kg K_2O/fad in both seasons, respectively. However, Herlihy (1989) reported that the agronomic effect of K was to increase yield rather than quality, consistent with its dominant rate in increasing the sink capacity and mass of the storage root. These results agree with those of Beringer *et al.* (1986), Sobh *et al.* (1992), El-Ramady (1997), El-Hawary (1999) and Omar *et al.* (2002).

On the other hand, gross sugar percentage in root juice was not significantly affected by increasing potassium rates from 24 to 48 kg K_2O/fad in both seasons.

Nitrogen fertilizer rates had a highly significant effect on sugar yield per faddan in both season. Sugar yield was increased by increasing of N-fertilization up to 120 kg N/fad. Such effect reflects the response of root yield to N-fertilizer. Since sugar yield is related not only to root yield but also to the other characters such as leaf area index, root diameter and dry matter accumulation which increased by increasing of N-fertilizer rates. Later in the season, nitrogen maintains this increase of dry matter in leaves and peticles and also increase dry matter production.

This is reflected in sugar production per unit area. The highest sugar yield (7.68 and 8.00 t/fad) were obtained from a rate of 120 kg N/fad. in both seasons, respectively Table 3. Similar results were also recorded by Zalat (1986), Singhania and Sharma (1990) and Sharief and Eghbal (1994). On the other hand, root sugar content decreased by increasing nitrogen from 80 to 120 kg N/fad. (Toor and Bains, 1994 and Nemeat Alla, 1997).

The interaction effect between potassium and nitrogen on sugar yield was significant during the first season, only.

2. White sugar yield:

The white sugar yield in an important yield parameter of sugar beet because it is the final useful form of sugar that the consumer use. The mean values of extractable white sugar percentage and yield (t/fad) at harvest as affected by potassium and N-fertilizers are presented in Table 3.

Concerning K-fertilizer rates, data showed insignificant differences existed among them. At the same time the 48 kg K_2O gave the lowest white sugar % and ranked last, while the highest values were obtained at 24 kg K_2O in both seasons. In contrast, El-Kammah (1995) found that white sugar % significant increased by increasing of K fertilizer rates. On the other hand, white sugar yield was significantly affected by increasing potassium rates from 24 to 48 kg K_2O/fad in the first season. The highest average values (5.93 and 5.97

t/fad) were obtained from 48 kg K_2O/fad in both seasons. Hilal (2005) found that application of 48 kg K_2O/fad produced the highest white sugar yield.

Carter (1986 a and b) pointed out that sucrose recovery efficiency from the sugar beet depends on the amounts and types of root and/or extracted juice impurities. The proportion and amount of K in the beet plant may also be important because of a positive correlation between K-fertilization and sucrose concentration in the root.

Table 3: Sugar yield, white sugar yield and beet root juice quality as affected by rates of K and N application in 2002/2003 and 2003/2004 seasons.

Characters / Treatments	Sugar yield	White sugar yield	Gross sugar	White sugar	Loss sugar	Juice purity	K	Na	α-amino N
Treatments	t/fad.		%				meq/100g		
	2002.2003 season								
Potassium rates (Kg K_2O/fad) :									
24	6.83	5.43	18.65	14.82	3.57	80.17	7.08	1.58	4.19
36	7.30	5.81	18.47	14.71	3.76	79.58	7.52	1.78	4.84
48	7.49	5.93	18.32	14.56	3.93	78.47	7.49	1.94	4.28
F. test	**	**	NS	NS	NS	NS	NS	NS	NS
LSD	0.17	0.20	-	-	-	-	-	-	-
Nitrogen rates (kg N/fad):									
80	6.84	5.38	19.27	15.81	3.57	81.68	6.78	1.50	4.48
100	7.41	5.80	18.35	14.36	3.80	78.57	7.36	1.97	4.53
120	7.68	5.99	17.81	13.92	3.89	77.97	7.94	1.84	4.49
F. test	**	**	**	**	**	**	***	**	NS
LSD	0.10	0.10	0.30	0.31	0.15	0.84	0.49	0.14	-
Interaction (K × N):	*	**	*	N.S	*	*	*	*	**
	2003/2004 season								
Potassium rates (kg K_2O/fad) :									
24	7.35	5.59	18.99	14.60	4.39	76.8	8.12	2.43	5.18
36	7.91	6.17	18.87	14.79	4.43	77.18	8.20	2.43	4.60
48	8.11	5.97	18.73	13.94	4.79	74.02	8.78	2.49	6.75
F. test	**	NS	NS	NS	NS	NS	NS	NS	NS
LSD	1.09	-	-	-	-	-	-	-	-
Nitrogen rates (Kg N/fad) :									
80	7.43	5.50	19.40	15.03	4.43	76.27	8.12	2.32	5.44
100	7.93	6.05	18.75	14.312	4.44	76.10	8.18	2.39	5.61
120	8.00	6.17	18.44	13.99	4.45	75.63	8.18	2.54	5.49
F. test	**	**	**	**	NS	NS	NS	NS	NS
LSD	0.13	0.19	0.21	0.22	-	-	-	-	-
Interaction (K × N):	N.S	*	**	**	N.S	*	*	**	*

With respect to the effect of N-fertilizer rates, data in Table 3 revealed that maximum white sugar % for both seasons 15.81% and 15.03% obtained from 80 kg N/fad. Meanwhile, the lowest one was obtained from application of 120 kg N/fad. The highest average values of white extractable sugar yield 5.99 and 6.17 t/fad were obtained at 120 kg N/fad in both seasons, respectively. In general, the trend of white sugar yield results are similar to those of gross sugar yield. It is worthy to mention that depressive effect of nitrogen on extractable white sugar and juice purity percentage was compensated by higher root yield and finally increased white sugar yield per faddan. This results agree with those obtained by O'conner (1983), Mahmoud *et al.* (1990), Nemeat Alla (1997), El-Zayat (2000) and Hilal (2005).

The interaction between K and N fertilizer rates had significant effect on white sugar yield in both seasons (Table 4). Beets received 36 or 48 kg K_2O fad plus 100 or 120 kg N/fad. produced the highest white sugar yield. While those received (24 kg $K_2O\times$ 80 kg N) produced the lowest one Table 4.

Table 4: White sugar yield as affected by the interaction between potassium and nitrogen fertilizer rates in 2002/2003 and 2003/2004 seasons.

Potassium rates (kg K_2O/fad)	White sugar yield t/fad Nitrogen rates (Kg N/fad)		
	80	100	120
	2002/2003 season		
24	4.94	5.51	5.86
36	5.49	5.94	6.00
48	5.71	5.96	6.12
LSD	0.22		
	2003/2004 season		
24	5.05	5.81	5.92
36	5.99	6.26	6.23
48	5.45	6.09	6.36
LSD	0.71		

3. Loss sugar (%):

The effect of different levels of K and N fertilizer rates on the sugar losses percentage in both seasons were presented in Table 3. Different levels of K and N-fertilizer had no significant effect on the percentage of sugar losses at both seasons.

In general, data show that the sugar loss % was slightly increased by increasing of K-fertilizer rates up to 48 kg K_2O/fad and by 120 kg N/fad similar results were also recorded by El-Kammah (1995), El-Ramady (1997) and El-Zayat (2000).

The interaction between K and N had significant effect on sugar loss % at the first season but it had no significant effect at the second one.

4. Juice purity (%):

Data in Table 3 show the effect of potassium and nitrogen fertilizer levels on juice purity % at both seasons. There was no evidence for significant difference in juice purity percentage due to K-fertilizer rates in both seasons. The obtained results were in general agreement with those of El-Zayat (2000). In contrast El-Kammah (1995), El-Ramady (1997), Omar (1996) and Hilal (2005) they found that purity percentage was significantly increased by increasing of K fertilizer rates. Also, Bosemark (1993) reported that the chemical characteristics of sugar beet juice was mainly affected by the sugar crystallization processes. There are high sucrose content associated with low contents of Na, K, alpha-amino-N and betaine contents. It is also important for the stability of juice in the factory that the content of alpha-amino-N would be maintained low in relation to that of Na and K ions.

Different levels of nitrogen fertilizer had a significant effect on purity percentage only in the first season. Purity of juice was decreased by increasing nitrogen fertilization up to 120 kg N/fad. The highest purity percentage (81.68 and 76.27% at first and second seasons, respectively) were obtained from 80 kg N/fad while, the lowest values were obtained from 120 kg N/fad. That is to say, that the drop in juice purity largely reflect on increase in the concentration of amino compounds caused by excessive uptake of nitrate late in the season. It is of interest to note that Follett (1991) reported that the increased cations concentration might be associated with a decrease in the sucrose. This was associated with an increase in content of water (low dry content) in fresh sugar beet roots which caused a dilution effect in the sucrose concentration. The non-sucrose constituents that decrease sucrose crystallization might include: Carbonate chloride, amino acids, betaine, glutamic and other organic acids and sulfate. Therefore, not only sucrose percentage, but also juice purity might be expected to increase as the sum of cations decrease. Similar results were obtained by Zalat (1993), El-Ramady (1997), Nemeat Alla (1997), Azzazy (1998) and Hilal (2005).

The interaction effect between K-and N-fertilizer rates were significant in both seasons. Data in Table 5 show that the highest juice purity % were (82.15 and 79.10%) obtained by (24 Kg K_2O × 80 Kg N/fad) in the second season, and by (36 kg K_2O × 80 kg N/fad) in the first season, while the lowest values were 75.75 and 73.40% with 48 kg K_2O × 120 kg N/fad. in both seasons, respectively.

Table 5: Juice purity percentage as affected by the interaction between K-and N-fertilizer rates in 2002/2003 and 2003/2004 seasons.

Potassium rates (kg K_2O/fad)	Juice purity percentage		
	Nitrogen rates (Kg N/fad)		
	80	100	120
	2002/2003 season		
24	82.15	78.75	79.60
36	81.10	79.10	78.55
48	81.80	77.85	75.75
LSD	2.05		
	2003/2004 season		
24	75.95	78.20	76.25
36	79.10	76.70	75.75
48	73.75	74.90	73.40
LSD	5.75		

5. Soluble non-sugars :

The soluble non-sugars, K, Na and α-amino-N in fresh root (mg/100g beet) are regarded as impurities because they interfere with sugar extraction. Means of these impurities as affected by K-and N-fertilizer rates are presented in Table 3. There was no evidence for significant difference in soluble non-sugars due to K-and N-fertilizer rates in the two seasons.

However, the data illustrated in Table 3 cleared that regardless of this slight increase in soluble non-sugars of sugar beet fertilized by different rates of potassium and nitrogen was noticed.

REFERENCES

Abd El-Aziz, S.M.; W.N. Dimian; L.A. Hussein and S.I.M. Essa (1992). Effect of boron and potassium on the chemical composition and growth of sugar beet in sandy soil under different irrigation systems. Zagazig. J. Agric. Res., 19 (1): 595-606.

Abd El-Wahab, S.A.; A.A. Amer; M.L. El-Shawy and M.M. Sobh (1996). Effect of different irrigation amounts and potassium fertilizer rates on yield and quality of sugar beet and water efficiencies. J. Agric. Sci. Mansoura Univ., 21 (12) 4687-4699

Abo El-Wafa, A.M. (2002). Effect of plant spacing, nitrogen rates and frequency on yield and quality of kawemira sugar beet variety under upper Egypt Conditions. J. Agric. Sci. Mansoura Univ., 27 (2): 707-716.

Azzazy, N.B. (1998). Effect of sowing date, irrigation interval and nitrogen fertilization on yield and quality of sugar beet under upper Egypt conditions. Egypt. J. Agric. Res. 76 (3): 1099-1113.

Beringer, H.; K. Koch and M.G. Lindhour (1986). Sucrose accumulation and osmotic potentials in sugar beet at increasing levels of potassium nutrition. J. Sci. Food Agric. 37: 211-218.

Bosemark, N.D. (1993). Genetics and breeding in Cooke, D.A. and R.K. Scott (ed.) 1st ed. The sugar beet crop. PP. 67-119. Chapman & Hall, London.

Carter, J.N. (1986a). Potassium and Sodium uptake effects on sucrose concentration and quality of sugar beet roots. J. of the A.S.S.B.T. 23 (384): 183-202.

Carter, J.N. (1986b). Potassium and sodium uptake by sugar beet as affected by nitrogen fertilization rate, location and year. J. of the A.S.S.B.T. (3 & 4): 121-141.

Cooke, D.A. and R.K. Scott (1993). The sugar beet crops. Charman and Hall London.

Edris, A.S.A.; N.A.N. El-Din; H.M. Geddaw and A.M.A. El-Shafei (1992). Effect of plant density, nitrogen and potassium fertilizers on yield and its attributes of sugar beet. Pakistan Sugar. J., 6 (3): 21-24.

El-Essawy, (1996). Effect of nitrogen, phosphours and potassium fertilizers on yield and quality of sugar beet (Beta vulgaris L.). J. Agric. Res. Tanta Univ., 22 (2).

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

El-Hawary, M.A. (1999). Influence of nitrogen, potassium and boron fertilizer levels on sugar beet under salin soil conditions. J. Agric. Sci. Mansoura Univ., 24 (4): 1573-1581.

El-Kammah, M.A. (1995). Quantity of sugar beet biomass as affected by interrelation ships of water irrigation regimes and fertilization. J. Agric. Sci. Mansoura Univ., 20 (12): 5249-5263.

El-Ramady, H.R.H. (1997). Response of sugar beet to nitrogen and potassium dressing at different levels of soil salinity, M.Sc. Thesis, Faculty of Agric. Kafr El-Sheikh, Tanta Univ.

El-Shahawy, S.A. Abd El-Wahab; M.M. Sobh and E.A.E. Neamet Alla (2002). Productivity and NPK uptake of sugar beet as influenced by N, B and Mn fertilization. J. Agric. Sci. Mansoura Univ., 27 (3): 1955-1964.

El-Sheref, E. El-M. (1998). Effect of phosphorus and nitrogen fertilizers on yield and quality of sugar beet (*Beta vulgaris*, L.). J. Agric. Res. Tanta Univ., 24 (1) P.76-88.

El-Zayat, M.M. (2000). Effect of irrigation regime and fertilization on sugar beet. Ph. D. Thesis, Faculty of Agric. Kafr El-Sheikh, Tanta Univ.

Emara, T.K. (1990). Effect of irrigation intervals, growth regulatiors and NK fertilizers on yield and quality of sugar beet. M.Sc. Thesis, Fac. of Agric. Mansoura Univ., Egypt.

Follett, R.F. (1991). Seasonal sucrose, dry matter and cation concentrations of sugar beet as influenced by variety and N-fertilization. Commu Soil Sci. Plant Anal. 22 (9-10): 893-906.

Harvey, C.W.; J.V. Dutton (1993). Root quality and processing PP. 571-617. In the sugar beet crop: Science into practice, Edited by D.A. Cooke and Scatt published 1993 by chapman 8 Hall. ISBN 041225132.

Hassanin, M.A. and S.E.D. Elayan (2000). Effect of phosphours and nitrogen rates and time of nitrogen application on yield and juice quality of sugar beet. J. Agric. Sci. Mansoura Univ., 25 (12): 7389-7398.

Hassouna, M.G. and M.A. Hassanein (2000). Sugar beet yield and quality as affected by biological and mineral nitrogen fertilization in the newly reclaimed areas at Nubaria region. Alex. Sci. Exch., 31 (3): 311-219.

Hegazy, M.H.; N.S.M. Abo-Soliman; K.M. Sayed and M.A. Abo El-Soud (1992). Effect of rate and time of K-fertilization on yield and quality of sugar beet. Egypt. J. Appl. Sci., 7 (4): 396-403.

Herlihy, M. (1989). Effect of potassium on sugar accumulation in storage tissue. Proc. 12th colloguium Int. Potash Institute, Bern.

Hilal, S.M.M. (2000). Effect of some cultural treatments on yield and quality of sugar beet (*Beta vulgaris*, L.). M. Sc. Thesis faculty of Agriculture Kafr El-Sheikh. Tanta Univ.

Hilal, S.M.M. (2005). Response of sugar beet crop to application of biological and chemical fertilizers under North Delta conditions. Ph. D. Thesis faculty of Agriculture Kafr El-Sheikh. Tanta Univ.

Johnson, R.T.; T.A. John; E.R. Geore and R.H. George (1971). Advances in sugar beet production: principles and practices. The Iowa State University press, Ames, Lowa, USA.

Kandil, A.A.; H. Leith and A.A. Al-Masoom (1993). Response of some sugar beet varieties to potassic fertilizers under salinity conditions. Proc. of the ASWAS Conf., 8-15.December 1993, Al-Ain United Arab Emirates, 199-207.

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

Mahmoud, E.A.; N.A., Khalil and S.Y. Besheet (1990). Effect of nitrogen fertilization and plant density on sugar beet 2-Root weight, root, top and sugar yields and sugar quality. Proc. 4th. Conf., Agron., Cairo, 15-16 Sept., Vol. 11: 447-454.

McGinnus, R.A. (1971). Sugar beet technology. 2nd ed. Sugar beet Development foundation, Fort., Collins., Color, USA.
Mohamed, A. I. B. (2004). Response of sugar beet plants to mineral and biological fertilization in North Delta. Ph. D. Thesis, Fac. of agric., Al-Azhar Univ.
Moustafa, S.N. and S.D. Darwish (2001). Biochemical studies on the efficiency use of some nitrogen fertilizers for sugar beet production. J. Agric. Sci. Mansoura Univ., 26 (4): 2421-2439.
Moustafa, S.N.; M.G. Beshay and K.A. Aboushady (2000). Influence of nitrogen fertilizer on some quality, technological aspects productivity and amino acids accumulation of sugar beet. J. Agric. Sci. Mansoura Univ. 25 (8): 4795-4806.
Neamet Alla, E.A.E. (1991). Some agronomic practices on growth and yield of sugar beet. M. Sc. Thesis, Fac. Agric., Kafr El-Sheikh, Tanta Univ.
Nemeat Alla, E.A.E. (1997). Agronomic studies on sugar beet. Ph.D. Thesis, Fac. Agric., Kafr El-Sheikh, Tanta Univ.
O'Connor, L.J. (1983). Influence of nitrogen fertilize, plant density, row width and their interactions on sugar beet yield and quality. Irish. J. Agric. Res., 22 (2 and 3): 189-202.
Omar, E.H. (1998). Studies on the effect of mid-tolate season drought and potassium fertilization on water relation and yield of sugar beet crop at North Delta. Ph.D. Thesis. Fac. Agric. Tanta Univ.
Omar, M.A.; M.A.A. Abd Allah and M.M. Ragab (2002). Response of sugar beet to termination of last irrigation, hill spacing and K-fertilization. J. Agric. Sci. Mansoura Univ., 27 (6): 4291-4302.
Ramadan, B.S.H. (1997). Sugar beet yield and quality as affected by nitrogen and potassium fertilization. Pakistan-Sugar, J., 11 (1): 8-13.
Reinefeld, El.; A. Emmerich, G. Baumagrten, C. Winner and U. Beiss (1974). Zur Voraussage des Melassezuckers aus Rubenanalysen. Zucker 27: 2-12.
Rozbicki, J.; Z. Dun and M. Kalinowska (1993). Investigations on the effect of the morphological structure of the plant stand on the yield and technological values of sugar beet against the back ground of sowing method and nitrogen fertilizer application. I Root yield and its structure and leaf yield. Roczniki Nouk Rolniczych. Seria A, Produckcja Rostinna. 110 (1-2) 69-76. [C.F. Field crop Abst. 47 (11): 7302].
Saif, L.M. (2000). Stepwise regression and path coefficient analysis for some sugar beet characters under levels of boron and nitrogen fertilization. Proc. 9th Conf. Agron., Minufiya Univ., 1-2 Sept. 2000: 569-581.
Samwel, L.T.; L.N. Werner and D.B. James (1990). Soil fertility and fertilizers (4th Ed.) Mac Millan. Company, New York.
Sayed, K.M. (1988). Fertilization of sugar beet grown on different soils of Kafr El-Sheikh governorate. Ph. D. Thesis, Fac. Agric. Mansoura Univ.
Selim, S.H.H. (1998). Effect of some agricultural treatments on sugar beet (*Beta vulgaris*, L.). Ph. D. Thesis Fac. Agric. Mansoura Univ.
Sharief, A.E. and K. Eghbal (1994). Yield of seven sugar beet varieties under different levels of nitrogen in dry region of Egypt. Agribiol. Res. 47 (3-4): 231-241.

Sharief, Z.A. Mohamed and S.M. Salama (1997). Evaluation of some sugar beet cultivars to NPK fertilizers and yield and lysis. J. Agric. Sci. Mansoura Univ., 22 (6): 1886-1903.
Singhania, R.A. and R.K. Sharma (1990). Nitrogen and phosphorus requirement of sugar beet in saline sodic soils. J. of the Indian Soci. of Soil Sci., 38 (2): 330-332.
Sobh, M.M.; S.A. Genaidy; M.Hegazy and A.Y. Negm (1992). Effect of nitrogen, phosphorus and potassium fertilization on sugar beet (*Beta vulgaris*, L.). Proc. 5th Corf. Agron. Zagazig, 13-15 Sept., (2): 945-953.
Steel, R.G. and J.D. Torrie (1984). Princeples and procedures of statistics (2d ed.) Mc Grow Hill Book Co. In. New yourk.
Sultan, M.S.; A.N. Attia; A.M. Salama; A.E. sharief and E.H. Selim (1999). Biological and mineral fertilization of sugar beet under weed control; 1-Sugar beet productivity. First International Conference on Sugar and Integrated Industries, Luxor Egypt, Feb. 15-18th, 1: 171-181.
Toor, S.S. and B.S. Bains (1994). Optimizing nitrogen fertilization for higher yield and quality of sugar beet. Moderas-Agricultural, 81: 12, 689-691.
Wallingford, W. (1980). Functions of potassium in plants. *In* potassium for agriculture. Potash and phosphate Institute, 10-27.
Winter, S.R. (1986). Nitrate-nitrogen accumulation in furrow irrigated fields and effects on sugar beet production. J. of the A.S.S.B.T. 23 (3): 174-182.
Zalat, S.S. (1986). Studies on sugar beet. M.Sc. Thesis, Faculty of Agric., Zagazig University.
Zalat, S.S. (1993). Effect of some cultural practices on sugar beet. Ph.D. thesis, Fac. of Agric., Zagazig Univ. Egypt.

تأثير التسميد البوتاسى والأزوتى على محصول وجودة بنجر السكر المنزرع فـى شمال الدلتا

عبدالمغازى محمد الشريف
قسم المحاصيل – كلية الزراعة بكفرالشيخ – جامعة طنطا

أقيمت تجربتان حقليتان فى المزرعة البحثية بكلية الزراعة بكفرالشيخ – جامعة طنطا خلال موسمى ٢٠٠٢/٢٠٠٣ و ٢٠٠٣/٢٠٠٤ وذلك لدراسة استجابة محصول وجودة بنجر السكر للتسميد البوتاسى والأزوتى تحت ظروف شمال الدلتا.

استخدم تصميم القطع المنشقة مرة واحدة فى ثلاث مكررات حيث وزعت معدلات التسميد البوتاسى (٢٤، ٣٦، ٤٨كجم بو٢أ/فدان) عشوائيا فى القطع الرئيسية. فى حين وزعت معدلات التسميد الأزوتى (٨٠ و ١٠٠ و ١٢٠كجم نتروجين/فدان) فى القطع المنشقة.

ويمكن تلخيص أهم النتائج المتحصل عليها كما يلى :

١- أدت زيادة معدل التسميد البوتاسى بـــ ٤٨كجم بو٢أ/ فدان الى زيادة كل من محصول العرش والجذور وكذلك محصول السكر/فدان. فى حين لم يؤثر التسميد البوتاسى معنويا على كل من المواد الغير سكرية (الشوائب). نسبة السكر – السكر المفقود – درجة نقاوة العصير.
٢- بزيادة التسميد الأزوتى الى معدل ١٢٠كجم نتروجين/فدان أدت الى زيادة واضحة لكل من قطر الجذور – محصول العرش – محصول الجذور – محصول السكر بالطن/فدان.
٣- عموما يمكن التوصية بتسميد بنجر السكر وذلك باضافة ٤٨كجم بو٢أ مع ١٢٠ كجم نتروجين/فدان. بغرض زيادة كل من المحصول والجودة تحت ظروف منطقة شمال الدلتا.