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EFFECT OF SOIL AND FOLIAR APPLICATION OF NITROGEN AND POTASSIUM ON SUGAR BEET

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Abstract

Studies were carried in the Research Experimentl farm of the Faculty of Agriculture Saba Basha, Alexandria University during 1994/95 and 1995/96 seasons to study the effect of potassium (0.0, 24 and 48 K_2O/fed) fertilizer as well as the foliar (0.5, 1.0 and 1.5% N) and soil application (0, 30, 60 and 90 Kg N) of Nitrogen fertilizer on sugar beet plant.

Results show that increasing the rate of K fertilizer from zero up to 48 kg K_2O/fed increased significantly root length, root perimeter, root weight, root/shoot ratio, sugar yield per plant, root and sugar yields ton/fed. Meanwhile, total plant weight, sucrose percentage and purity percentage were significantly increased by increasing potassium level up to 24 kg K_2O per fed. Further increase in potassium fertilizer up to 48 kg K_2O caused a significant decrease in purity percentage as well as in top weight than those under 24 kg K_2O/fed.

Increasing rate of nitrogen to 90 kg N/fed as soil application or to 1.5% N as foliar application caused a significant increase in root length, root perimeter, root and top weight per plant, total plant weight, sugar yield/plant, root and sugar yields/fed., T.S.S., Sucrose% and purity % while root/shoot ratio was significantly decreased.

There was a significant effect on the interaction between K and N on the root and sugar yields of sugar beet, whereas 48 kg of K_2O in combination with 1.5% N as foliar application or 90 kg N/fed as soil application had superior effect on root and sugar yields of sugar beet.

INTRODUCTION

Sugar beet is a specialized type of *Beta vulgaris* L. grown for sugar production and is considered the second important sugar crop in Egypt after sugar cane.

Production of greater root tonnage doesnt solve all of the problems affecting profitable production. Equally important is the percentage of sucrose in the root and the total yield of sugar.

Evans and Sorger (1966) reported that potassium is especially involved in the conversion of solar energy into chemical energy and is required for the active conformation of many enzymes participating in intermediary metabolism and biosynthesis. As well as Nitrogen has the greatest influence of all the mineral elements on root quality and sucrose production.

Singh et al (1985) reported that foliar application of N at 75 kg N/ha as a 5% spray was almost as good soil application at 150 kg N/ha with mean commercial cane sugar yields of 9.95 and 10.09 tonnes/ha respectively. Faber and Krsz kowska (1990) received low sugar beet N rates and was given 0, 70, 140 or 210 kg N/ha before sowing combined with 0, 40, 80, or 120 kg N as top dressing when the plant had 3 pairs of leaves. They found that root yield increased from 42.8 to 47.4 t/ha with increasing rates of basel N and from 44.6 to 47.7 t with increasing rates of top-dressed N. Leaf yield also increased with increasing N rates but root sugar content and sugar yield were not significantly affected.

Rucka (1993) reported that the highest root yield (84.68 t/ha) of sugar beet was obtained by application of 400 kg N/ha. Sharif and Eghbal (1994) applied to sugar beet plant 0, 50, 100 or 150 kg N/ha in 2 split applications at the 2 nd and 3 rd irrigation and reported that root length, root diameter, LAI and root, top and sugar yields increased with increasing levels of nitrogen application up to 150 kg N/ha whereas contents of total solids and sucrose and juice purity percentage decreased with increasing N rates up to 150 kg N/ha. Moustafa (1996) reported that chlorophyll A, root/shoot ratio, root length, root weight, root yield/fed., sugar yield/ fed, T.S.S. and sucrose percentage were not significantly affected by nitrogen levels, while number of leaves/plant, root perimeter, total plant weight and top yield per fed were significantly increased by the application of 100 kg Nfed. He added that the increase in K level up to 48 kg K2O, significantly increased leaves number, dry weight and LAI of leaves and weight and perimeter of root as well as top and root yield/fed. Sobhy et al (1992) showed that length and yield of root, juice purity %, sucrose % and sugar yield significantly increased by increasing K rate. Whereas application of 25 or kg K2O/fed induced the same effect on root and sugar yield. Orlovius (1993) in a field experiment investigated the effect of various levels of applied K-fertilizer 0,100, 200, 300, 500 and 600 kg K2O/ha at two sites. Available soil K at the outset was 210 mg/kg at site 1 and 260 mg/kg at site 2. He observed that potash increased sugar content by about 5% in both sites.

Basha (1994) studied the effect of K fertilizer levels (25, 50, 75 and 100 kg K2O/fed.) on yield and quality of sugar beet. Results showed that adding K fertilizer at rate of 100 kg K2O/fed resulted in increasing significantly plant height, root length and diameter, root and forage weights/plant, root, top and sugar yields (ton/ fed.), sucrose%, TSS% and apparent purity.

The purpose of this study is to find out the optimum level and method for N and K application to induce the highest yield and the best quality for sugar beet, Desprez variety.

MATERIALS AND METHODS

Two field experiments were carried out at Rersearch Experimental Farm of the Faculty of Agricultural, Saba Basha, Alexandria University during 1994/95 and 1995/96 seasons, to investigate the effect of potassium fertilizer as well as the foliar and soil application of nitrogen fertilizer on root and shoot characters, yield and some technological properties of sugar beet.

Every experiment included 21 treatments representing the combination of three levels of potassium (0, 24 and 48 K2O) in the form of potassium sulphate (48% K2O) and seven treatments of nitrogen (0.% 1.0 and 1.5% N as foliar appliar at a rate of 600 litre/fed and 30, 60 and 90 kg N/fed as soil application in the form of urea (46.5% N) in addition the control treatment without N-fertilization).

Potassium and nitrogen either in foliar or soil application were applied in two equal doses. The first dose was added after thining, whereas the second was applied one month later. calcium superphosphate (15.5% P2O5) was incorporated in the soil during land preparation at a rate of 30 kg P2O5/fed. Other cultural practices of sugar beet were carried out as usual.

Desprez variety of sugar beet was sown on 25 October and 1st November in the first and second seasons, respectively. The preceeding crop was maize.

In both seasons the treatments were arranged in complete randomized block design with four replications. The area of each plot was 10.5 m2 (3m X 3.5m) with six ridges which were 50 cm apart and 3.5 m in length.

At harvest time (190 days after sowing) root and complete randomized block yield and some technological characters of sugar beet were recorded from the plants of the four middle ridges. While 1st and 6th ridges from each plot were left as borders. The following data were recorded:

I. Root and shoot characteristics :

- Length and perimeter of root
- Weight of root, top and the total plant
- Root/shoot ratio

II. Quality and technological properties :

- Total soluble solids (T.S.S. %) was determined with a hand refractometer.
- Sucrose percentage was determined according to the procedure of Le Docte (1927)
- Juice purity percentage.
- Sugar yield per plant/g.

II. Yield of sugar beet :

- Root yield ton/fed.
- Sugar yield ton/fed.

The data were subjected to proper statistical analysis of variance (Snedecor and Cochran, 1980). The treatment means were compared by using the least significant differences test (Waller and Duncan, 1969) at 5% level of significance.

RESULTS AND DISCUSSION

Effect of potassium fertilizer:

a. Root and shoot characteristics:

Data reported in Table (1) reveal the effect of different levels of potassium fertilization on root and shoot characters of sugar beet during 1995 and 1996 seasons.

It is clear that root length, root perimeter and weight of roots were significantly increased with each increasing in the level of potassium fertilizer from 0.0 to 24 and from 24 to 48 kg Kg K2O/fed. While, the top weight per plant was significantly decreased by increasing from 24 to 48 kg K2O/f potassium level. Those results were true in both seasons and are in agreement with those obtained by Kamel et al (1979), Abdel-Aal (1990) and Basha(1994).

Data in Table (1) reveal, also that potassium levels exhibited a significant increase in root/shoot ratio during both seasons of the study. This result may be due to the increase in the accumulation of dry matter in the roots of sugar beet under potassium application at a greater rate than in leaves.

Table 1. Effect of potassium fertilizer on root and shoot characters of sugar beet plant during 1994/95 and 1995/96 seasons.

Characters \ K_2O kg/Fed	1994/95 season			
	0.00	24	48	L.S.D 0.05
Root length (cm)	12.67	20.71	22.57	0.79
Root perimeter (cm)	25.28	30.89	34.04	0.88
Root weight/plant (kg)	0.658	0.827	0.867	0.027
Top weight/plant (kg)	0.892	0.796	0.714	0.034
Total plant weight (kg)	1.55	1.613	1.577	0.046
Root/shoot ratio	0.797	1.067	1.219	0.60
Characters \ K_2O kg/Fed	1994/95 season			
	0.00	24	48	L.S.D 0.05
Root length (cm)	12.35	20.67	23.04	0.569
Root perimeter (cm)	25.32	31.07	34.53	0.813
Root weight/plant (kg)	0.648	0.840	0.888	0.028
Top weight/plant (kg)	0.929	0.800	0.715	0.047
Total plant weight (kg)	1.577	1.641	1.603	0.038
Root/shoot ratio	0.767	1.085	1.24	0.052

b. Technological and quality properties :

Data reported in Table (2) show that total soluble solids TSS was significantly increased by used potassium fertilizer up to 24 kg K_2O/fed. in the first season and up to 48 kg K_2O/fed in the second season. Whereas the sucrose percentage was significantly increased under 24 kg K_2O/fed for both seasons compared with the control treatment (without potassium fertilization), and the highest level of potassium (48 K_2O/f) has the same effect as middle level of potassium fertilization (24 kg K_2O).

In this respect Orlovius (1989) reported that differences in Polarisation and percentage of sugar content were small under different levels of potassium. Herlihi (1992) stated that the primary agronomic effect of K was to increase yield, with minimal effect on sugar content.

Purity was significantly increased under 24 and 48 kg K2O compared with control treatment (0 K2O/fed). However purity at 24 kg K2O/fed was significantly higher than that at 48 kg K2O/fed in the both seasons.

Concerning the effect of potassium fertilizer on sugar yield per plant, data in Table (2) reveal that increasing K levels caused a gradual increase in sugar yield in the root of sugar beet for both growing season. Those results are supported by those of Sobhy et al (1992), El-Hawary (1994) and Basha (1994).

Table 2. Effect of potassium fertilizer on some technological properties of sugar beet plant during 1994/95 and 1995/96 seasons.

	1994/95				1995/96			
K2O kg/Fed properties	0.00	24	48	L.S.D 0.05	0.00	24	48	L.S.D 0.05
T.S.S %	13.85	18.5	18.8	0.404	13.65	18.29	19.15	0.351
Sucrose %	11.35	15.45	15.7	0.299	11.11	15.31	15.36	0.268
Purity %	81.4	83.07	82.96	0.0009	80.82	83.32	82.82	0.008
Sugar yield/plant in g	75.0	129.3	137.6	4.32	72.0	130.4	143.1	4.88

C. Yield of sugar beet :

Data reported in Table (3) show the effect of potassium fertilization levels on root yield and sugar yield per feddan during 1994/95 and 1995/96 growing seasons.

It is interesting to mention that in both seasons of the study, root yield ton/ fed. was significantly increased by increasing the potassium levels. The percent increase in root yield of sugar beet under 24 and 48 K2O/fed. were 25.78% and 31.81% in first season as well as 29.69% and 36.97% in second season over the control treatment (without potassium fertilizer). Such increase may be due to increase in root growth as previously shown in Table (1).

Data reported in Table (3) show, also that sugar yield ton/fed. of sugar beet increased consistently as a result of increasing of K2O rate. Thus, the increasing as percentages in sugar yield per fed for the first season were 72.3% and 83.3% over the control for 24 and 48 kg K2O respectively, while the corresponding values were 80.7% and 98.5% for the second season.

Table 3. Effect of potassium fertilizer on yield of sugar beet plant during 1994/95 and 1995/96 seasons.

	1994/95				1995/96			
K2O kg/Fed properties	0.00	24	48	L.S.D 0.05	0.00	24	48	L.S.D 0.05
Root yield ton/Fed	18.42	23.17	24.28	0.733	18.15	23.54	24.86	0.79
Sugar yield ton/Fed	2.1	3.62	3.85	0.12	2.02	3.65	4.01	0.13

The present results indicated the importance of potassum fertilization is necessary to increase root and sugar yields of sugar beet.

These results are in agreement with those obtained by Orlovius (1989), Sobhy et al (1992), Bash (1994) and El-Hawary (1994). They reported that, sugar beet yields, generally increased with increasing K rate (Table 3 here)

Effect of Nitrogen fertilizer

a. Root and shoot characteristics:

Growth of sugar beet in terms of length, perimeter and weight of root and weight of shoot as well as root/shoot ratio as affected by different levels of nitrogen either by soil or foliar application is presented in Table (4).

Data of both seasons in Table (4) reveal that all root and shoot characters were significantly increased by the application of nitrogen. The greatest root length, root perimeter, top weight and total weight/plant were obtained by the soil application of 90 kg N/fed. While, the greatest root weight was obtained by spraying 1.5% nitrogen. Insignificant differences were detected between weight and perimeter root of plant fertilized with 90 kg N/fed as soil application and 1.5% N as foliar application. It contrast, that the application of nitrogen fertilizer either by spraying or soil application caused a significant decrease in root/shoot ratio was obtained by soil application of 60 kg N/fed. or spraying with 1% N/fed.

Table 4. Effect of nitrogen fertilizer on root and shoot characters of sugar beet plant during 1994/95 and 1995/96 seasons.

1994/95 season								
N levels	Foliar application				Soil application N kg/Fed.			L.S.D
Characters	0.00	0.5%	1%	1.5%	30	60	90	0.05
Root length (cm)	12.67	17.17	19.17	20.08	19.33	20.50	21.67	1.21
Root perimeter (cm)	23.08	27.58	31.0	33.92	28.08	32.50	34.33	1.34
Root weight/plant (kg)	0.588	0.67	0.792	0.927	0.719	0.860	0.909	0.040
Top weight/plant (kg)	0.452	0.68	0.913	0.887	0.759	0.925	0.993	0.052
Total plant weight (kg)	1.048	1.410	1.697	1.815	1.473	1.732	1.902	0.070
Root/shoot ratio	1.31	1.12	0.89	1.08	0.96	0.89	0.95	0.09
1995/96 season								
N levels	Foliar application				Soil application N kg/Fed.			L.S.D
Characters	0.00	0.5%	1%	1.5%	30	60	90	0.05
Root length (cm)	12.42	17.50	19.33	20.08	18.50	20.58	22.42	0.87
Root perimeter (cm)	22.75	27.83	31.25	34.08	29.25	32.42	34.58	1.24
Root weight/plant (kg)	0.583	0.773	0.801	0.940	0.753	0.773	0.920	0.043
Top weight/plant (kg)	0.435	0.723	0.906	0.927	0.752	0.926	1.011	0.72
Total plant weight (kg)	1.019	1.496	1.708	1.867	1.507	1.700	1.907	0.058
Root/shoot ratio	1.34	1.08	0.91	1.06	1.01	0.86	0.97	0.078

b. Technological and quality properties :

Results in Table (5) indicate that the nitrogen fertilization at any rate and by two methods of application significantly increased T.S.S., sucrose, purity and sugar yield per plant during both growing seasons.

Results for the two seasons indicated that N applied as foliar application at rate of 1% N was more effective in increasing T.S.S. and sucrose% than other treatments. Whereas, insignificant differences in the values of T.S.S. or sucrose were detected between the 60, 90 kg/fed basal application and 1.5% N as foliar application.

Table 5. Effect of nitrogen fertilizer on some technological characters of sugar beet plant during 1994/95 and 1995/96 seasons.

1994/95 season								
N levels	Foliar application				Soil application N kg/Fed.			L.S.D
Characters	0.00	0.5%	1%	1.5%	30	60	90	0.05
TSS %	13.87	16.85	18.53	17.74	17.16	17.66	17.53	0.618
Sucrose %	11.04	14.23	15.49	14.81	14.38	14.74	14.53	0.687
Purity %	79	83	83	83	83	83	83	0.014
Sugar yield/plant (g)	65.2	107.7	123.4	141.3	104.1	120.7	135.1	6.61
1995/96 season								
N levels	Foliar application				Soil application N kg/Fed.			L.S.D
Characters	0.00	0.5%	1%	1.5%	30	60	90	0.05
TSS %	14.08	16.66	18.26	17.66	17.40	17.61	17.58	0.637
Sucrose %	11.17	13.75	15.26	14.72	14.59	14.43	14.73	0.409
Purity %	79	82	83	83	84	83	83	0.013
Sugar yield/plant (g)	65.2	107.3	124.0	143.3	111.5	113.6	141.6	7.46

Concerning juice purity of sugar beet root, the lowest rate of nitrogen soil application (30 kg N/fed.) significantly increased purity% compared with all other treatments. Sugar yield per plant was significantly increased by nitrogen fertilization. Thus, 1.5% N treatment gave the highest sugar yield/plant and it was not significantly differed with 90 kg N/fed. for both seasons.

In this respect, Moustafa (1996) found that the sugar yield, total soluble solids and sucrose percent were not significantly affected by N levels. While, Sharif and Eghbal (1994) indicated that the contents of total solids, sucrose and juice purity percentage decreased with increasing N rate up to 150 kg N/ha.

c. Yield of sugar beet :

Yield of sugar beet in terms of root and sugar yields (ton/fed) were significantly increased by increasing the rate of N ferilizer either by spraying or soil method during both seasons as shown in Table (6).

Table 6. Effect of nitrogen fertilizer on yield (ton/Fed.) of sugar beet plant during 1994/95 and 1995/96 seasons.

1994/95 season								
N levels	Foliar application				Soil application N kg/Fed.			L.S.D
Characters	0.00	0.5%	1%	1.5%	30	60	90	0.05
Root yield ton/Fed.	16.46	21.28	22.19	25.97	20.14	22.58	25.08	1.12
Sugar yield ton/Fed.	1.82	3.02	3.47	3.96	2.92	3.38	3.79	0.19
1995/96 season								
N levels	Foliar application				Soil application N kg/Fed.			L.S.D
Characters	0.00	0.5%	1%	1.5%	30	60	90	0.05
Root yield ton/Fed.	16.33	21.65	22.45	26.32	21.09	21.65	25.78	1.21
Sugar yield ton/Fed.	1.83	3.01	3.47	4.01	3.12	3.18	3.97	0.20

The highest root and sugar yield were obtained by 1.5% N which did not significantly differed with 90 kg N/fed for both sugar and root yields. Whereas, the increase in root yields as percentages in root yield were 57.8 and 52.4% for first season under 1.5 N % and 95 Kg N treatments, respectively as compared with control. The corresponding values were 61.2 and 57.9% for the second season.

The increases in sugar yield ton/fed were 117.8% and 108.2% in first season and 119.1% and 116.9% in second season by rates of 1.5% N and 90 kg N/fed, respectively as compared with the unfertilized treatment.

These results are in agreement with those obtained by Zeidan et al (1987) and Assey et al (1992). Herlihi (1992) who indicated that the maximum N for root yield was 206 kg/ha, whereas optimum rate for yield of sugar was 150 kg/ha.

Interaction effect between K and N fertilizers on sugar beet yield

There was a statistical significant effect for the interaction between K rates and N levels on yield of root as well as yield of sugar ton/fed of Desprez variety in both growing seasons (Table 7).

The maximum root yield ton/fed in both seasons was obtained by applying 48 kg K2O/f in combination with 1.5% N as foliar application. The next treatment was 48 kg K2O + 90 kg N as soil application whereas, the difference between root yield under these two treatments was significant only in the first season. Similar results were obtained with yield of sugar.

It could be concluded that K fertilizer at rate 48 kg K2O in combination with N fertilizer at 1.5% N as foliar application or 90 kg N/fed as soil application had superior effect on sugar beet yield, Desprez variety.

Table 7. Interaction effect between potassium and nitrogen fertilizer on yield of sugar beet (ton/fed.) during 1994/95 and 1995/96 seasons.

	1994/95							1995/96						
N / K_2O	0.00	0.5%	1%	1.5%	30	60	90	0.00	0.5%	1%	1.5%	30	60	90
Root yield (ton/Fed.)														
0.0	15.54	19.11	20.65	19.32	18.41	19.39	16.59	16.17	19.67	19.88	18.34	18.2	18.4	16.38
24	17.08	21.56	22.47	26.18	21.63	24.36	28.91	16.24	22.47	23.03	27.72	22.96	22.89	29.47
48	16.21	23.17	23.45	32.41	20.37	24.01	29.75	16.59	22.82	24.43	32.9	22.12	23.66	31.5
L.S.D	1.828							1.316						
Sugar yield (ton/Fed.)														
0.0	1.59	2.23	2.46	2.2	2.1	2.25	1.87	1.67	2.17	2.22	2.1	2.1	2.04	1.82
24	1.9	3.28	3.99	4.31	3.34	3.94	4.55	1.82	3.39	3.92	4.82	3.64	3.67	4.72
48	1.96	3.54	3.94	5.36	3.29	3.95	4.91	1.98	3.45	4.28	5.53	3.63	3.83	5.34
L.S.D	0.335							0.118						

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تأثير التسميد النيتروجيني والبوتاسي (بالأضافة أو الرش) على نبات بنجر السكر

سامية سعد المغربى ، منى مكرم شحاته ، يسرية هانم توفيق

معهد بحوث المحاصيل السكرية - مركز البحوث الزراعية - الجيزة - مصر .

أقيمت تجربتان حقليتان بالمزرعه البحثية لكلية الزراعة - سابا باشا جامعة الاسكندرية خلال موسمى ١٩٩٤ / ٩٥ و ١٩٩٥ / ٩٦ لدراسة تأثير التسميد البوتاسيى (صفر - ٢٤ - ٤٨ كجم بو ٢أ / للفدان) وكذلك التسميد الازوتى بالرش (٠,٥٪ ، ١٪ ، ١,٥٪) او بالاضافة الارضية (صفر ، ٣٠ ، ٦٠، ٩٠ كجم ن / للفدان) على نبات بنجر السكر.

وتتلخص أهم النتائج فى :

زيادة معدل التسميد البوتاسيى من صفر الى ٤٨ كجم بو ٢أ للفدان أظهرت زيادة معنوية فى طول ومحيط ووزن الجذر وناتج السكر للنبات ونسبة الجذر الى العرش ومحصول الجذور ومحصول السكر للفدان بينما ووزن النبات والنسبة المئوية للسكروز بالجذور والنقاوة زادت معنويا بزيادة التسميد البوتاسى حتى ٢٤ كجم بو ٢أ للفدان وبزيادة التسميد حتى ٤٨ كجم بو٢أ ادى الى نقص النقاوة ومحصول العرش.

زيادة معدل التسميد الازوتى سواء اضافة ارضية او رش على النباتات ادى الى زيادة طول ومحيط الجذر ووزن الاوراق للنبات وون النبات الكامل ووزن الجذور ومحصول الجذور الى الاوراق نقصت معنوياً بزيادة معدل الاضافة.

كان للتفاعل المتبادل بين معدلات كل من البوتاسيوم والنيتروجين تاثير معنوى على محصول الجذور والسكر فى كلا الموسمين ونتج اعلى محصول سواء فى الجذور او السكر طن / للفدان فى حالة تسميد بنجر السكر بمعدل ٤٨ كجم بو ٢ أ / للفدان مع ٩٠ كجم ن / للفدان كاضافة ارضية او ١,٥٪ ن رش على المجموع الخضرى وذلك للصنف ديسبرس.