RESPONSE OF SUGAR BEET TO NITROGEN FERTILIZER AND SULPHUR SPRAY FREQUENCY IN MIDDLE EGYPT

OSMAN, M.S.H[1] AND MONA M. SHEHATA[2]

1. *Agronomy Dept. Sugar crops Res. Inst. ARC, Giza.*
2. *Physiology and Chem. Dept. Sugar crops Res. Inst. ARC, Giza*

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Abstract

Two field experiments were carried out in 2006/2007 and 2007/2008 seasons at Malawi Agricultural Experimental Research Station El Minia Governorate to study the effect of nitrogen soil fertilization level (60. 90 and 120 kg N/fed) and foliar fertilization of sulphur in the form of Calciume Poly Sulfide (30%) at concentration of 6 cm/L. which was applied (once at 70 days age, twice at 70 and 85 days as well as three times at 70, 85 and 90 days after sowing in addition to foliar spray with distilled water as control) on sugar beet Desperiz Poly N variety. The results indicated that:

Increasing nitrogen level up to 120 Kg/fed significantly increased growth of sugar beet root measurements (length, diameter and fresh weight) and its content from N, P, K, SO_4 and all amino acids (except cystein which increased more by 90 kg N/fed) as well as yield of roots.

However fertilization sugar beet plants by 90 kg N/fed significantly increased root quality percentages (total soluble solids, sucrose and purity) in addition it gave the highest sugar yield (ton/fed).

Foliar spray with sulphur solution twice or three times significantly increased diameter, fresh weight, yield of root and accumulation N, P, K, SO_4. while, some amino acids were increased and others were decreased in sugar beet root. Sulphur fertilization significantly decreased root quality measurements and it have insignificant effect on sugar yield. Fertilization sugar beet by 90 Kg N/F in combination with sulphur foliar spray three times during growing season obtained the greatest increases in root and sugar yield.

INTRODUCTION

Sugar beet is grown for sugar production and it is the second important source sugar crop after sugar cane. Production of greater root tonnage doesn't solve the problems affecting profitable production. Sucrose% of root juice and the sugar yield is considered the main goal from the industrial view, however, root yield in addition to juice quality is the main target for the growers to gain the highest net income.

Fertilization is the most important factor which has a distinct role on production of many crops. Nitrogen is an essential nutrient element for building up protoplasm of plants. Achieving higher growth, yield and best quality of sugar beet is

controlled by nitrogen fertilization, where as decreasing N level significantly decreased both of growth and yield, while excess amount of it increase impurity% of juice root. Several studies (Moustafa, Zeinab *et al* 2000, Ouda, Sohier 2002 Azzazy 2004, Moustafa, Shafika *et al* 2005 and Awad Allah *et al* 2007) indicated that sugar beet production of high yield with best quality requires that nitrogen be in adequate supply to develop an optimum canopy for photosynthesis and at the same time doesn't increase juice impurities of sugar beet.

Sulphur nutrient can significantly increase crop yield and improve its quality. It is indispensable for strong growth of plant, as it can involved in its metabolism in a host of ways as described in many basic text. Drycott (1972) stated that sulphur is a constituent element of some amino acids, namely cystein and methionine and it is involved in synthesis of chlorophyll. Sulphur, also plays an important role in the synthesis of certain vitamins, carbohydrates and proteins. In recent years, sulphur has received increasing attention as world soils are becoming deficient in this element for that, use of sulphur as free fertilization is important for increasing and improving crop production. Concerning sugar beet Sexton (1996), have established the important of sulphur in the quality characteristics of sugar beet particularly in the levels of α-amino nitrogen in roots which reduce juice purity and therefore the extraction sugar yield. Popovic *et al* (1996) indicated that in young sugar beet hybrid sulphur had a maintained the activity of nitrate reduce and glutamate dehydrogenises. Protein synthesis was also suppressed in the absence of sulphur in nutrient medium. Chloroplast pigment contents and dry mass were increased while nitrate content was decreased with increasing concentration of sulphur. Thomas *et al* (2000) observed increased in arginine, serine and alanine in sugar beet tissue under conditions of sulphur deficiency. While proline and S concentration were markedly reduced in response to sulphur deficiency with decrease in yield and deleterious on beet quality. On other hand Hoffmann *et al* (1998) in Germany, concluded that there is no need for sulphur application to sugar beet production. In Egypt many researcher studied sulphur effect on sugar beet production, Moustafa, Zeinab *et al* (2006) reported that response degree of growth, quality, chemical composition and yield sugar beet differ according to the level of sulphur fertilization, which used and the differences in soil and environmental factors. In plants metabolism sulphur is closely involved with nitrogen. Bell *et al* (1995) indicated that increasing the concentration of sulphur in the nutrient solution improved sugar beet purity through reduced alpha amino N whish was increased as a result from excess nitrogen fertilization. Ouida, Sohier (2002), Moustafa, Shafika *et al* (2005), Nemeat Allah (2005) and Awed Allah *et al* (2007)

found that the interaction effect between nitrogen and sulphur application had significant effect on some traits of sugar beet .

This study aimed to find out the optimum nitrogen rate and the suitable time for sulphur spray to induce high quality, root and sugar yield of sugar beet under Middle Egypt condition (El Minia Governorate).

MATERIALS AND METHODS

Two field experiments were conducted at Mallawi Agricultural Experimental Research Station, El Minia Governorate, during 2006/2007 and 2007/2008 seasons, to study the effect of nitrogen and sulphur fertilization as well as their interaction on sugar beet Desprez Poly N variety. A split plot design with three replications was used. The main plots were assigned to nitrogen fertilizer rates (60, 90 and 120 kg/fed was added in form of ammonium nitrate 33%N) in two equal doses after 30 and 45 days from sowing date, whereas, foliar spray of sulphur occupied the sub plots was added in form of Calcium Poly Sulfate (30%) at concentration of 6 cm/L (once at 70 days age, twice at 70 and 85 days age and at a three time 70, 85 and 90 days after sowing in addition to foliar spray with distilled water as control).

Sub plot area 10.5 m^2 consisted of 5 rows of 3.5 m long at 60 cm apart and spacing between hills 20 cm. Sowing dates were September 23th and 30th for the 1st and 2nd seasons, respectively. The cultural practices for sugar beet field were carried out as recommended. Chemical and physical properties of the experimental soil were determined according to Chapman and Pratt (1967) in Table 1.

At harvest time (210 days from sowing) the three guarded rows were harvested topped: A sample of 10 roots was randomely taken and the following characteristics were determined 1- Root dimensions. 2- Root fresh weight (kg/plant).
3- Total soluble solids (TSS%) was determined with a hand refractometer.
4- Sucrose% was determined according to the procedure of Le Dect (1927)
5- Purity% (Sucrose % x 100)/ TSS% according to Supernova *et al* (1979)
6- N, P and K of root (g/100 g DW).
7- Various amino acids% in root/DW basis were determined according to A.O.A.C. (1990). Sulphate% according to Johnson and Nishita (1952).
8- Root yield of sugar beet (ton/fed).
9- Sugar yield (ton/fed) was determined according to the method of Delta sugar Company where approscimately 3.07% the sucrose% is considered as a loss with industrial practices. It was calculated according to the following equation:
Sugar yield (ton/fed) = Yield of root (ton/fed) x adjusted sucrose%.

Data obtained were statistically analyzed according to Snedecor and Cochran (1981). Treatments means were compared by using the least significant difference (LSD) at 5% level.

Table 1. Chemical and physical properties of the experimental sites.

Property	Soil	
	2006/2007	2007/2008
Sand	8.10	7.63
Silt	61.21	61.87
Clay	30.69	30.50
Texture grade	Clay loam	Clay loam
$CaCO_3$ %	1.63	2.08
pH (1:2.5 soil suspension)	8.05	8.12
EC (ds/m, 1:5 soil water ext.).	1.16	1.11
Soluble ions (meq/100 g soil)		
Ca^{2+}	1.12	1.28
Mg^{2+}	1.04	1.22
Na^{+}	3.18	371
K^{+}	0.23	0.33
Cl	1.32	1.46
$CO_3^{2-} + HCO_3$	0.95	1.20
SO_4^{2-}	3.35	3.88
Available N (ppm)	38.48	45.13
Available P (ppm)	11.17	11.25
Available K (ppm)	78.12	81.15

RESULTS AND DISCUSSION

Data in Table 2 revealed that the effect of different levels of nitrogen and sulphur treatments as well as their interaction on length, diameter and fresh weight root in two growing seasons.

Results given showed that root growth measurements under study were gradually increased with the increase in N level. Moreover, such increases were significant except the differences between root length of plants received 120 kg N/fed and those plants fertilized by 90 kg N/fed in the 2nd season. Data in the 1st season indicated that the highest level of nitrogen (120 kg/fed) increased length, diameter and fresh weight root by 6.75 cm, 1.8 cm and 0.64 kg respectively compared with the lowest level (60 kg N/fed). The corresponding values were 10.2 cm, 2.8 cm and 0.79

kg in the 2nd season. These results were in agreement with those of Hashem *et al* (1997), Moustafa, Zeinab *et al* (2000), Azzazy (2004) and Awad Allah *et al* (2007) who found that growth criteria of sugar beet plants were significantly increased with increasing level of nitrogen fertilization.

Table 2. Effect of nitrogen and sulphur fertilizations on root characteristics of sugar beet.

Nitrogen (Kg/fed)	No. of sulphur application	2006/2007 Root			2007/2008 Root		
		Length (cm)	Diameter (cm)	Fresh weight (kg)	Length (cm)	Diameter (cm)	Fresh weight (kg)
60	S0	39.00	9.90	0.99	32.00	8.70	0.75
	S1	37.00	9.00	1.01	32.90	9.00	0.76
	S2	38.30	9.90	1.05	31.00	9.10	0.98
	S3	39.00	9.60	1.05	32.20	9.20	1.01
	Mean	38.32	9.60	1.02	32.02	9.00	0.88
90	S0	41.30	10.30	1.23	39.80	10.80	1.29
	S1	41.30	11.10	1.32	41.50	11.00	1.32
	S2	41.60	11.00	1.39	41.10	11.10	1.38
	S3	41.60	11.40	1.40	41.50	11.30	1.39
	Mean	41.45	10.95	1.34	40.97	11.05	1.35
120	S0	44.00	11.20	1.56	41.70	11.70	1.61
	S1	45.30	11.30	1.64	42.50	11.30	1.62
	S2	46.00	11.50	1.71	43.20	12.30	1.69
	S3	45.0	11.60	1.72	41.50	11.90	1.74
	Mean	45.07	11.40	1.66	42.22	11.80	1.67
Means of sulphur	S0	41.43	10.46	1.26	37.83	10.40	1.22
	S1	41.20	10.46	1.32	38.96	10.43	1.23
	S2	41.96	10.80	1.38	38.43	10.83	1.35
	S3	41.86	10.86	1.39	38.40	10.80	1.38
LSD at 5%							
Nitrogen levels (N)		1.322	0.132	0.270	2.831	0.579	0.205
Sulphur spray No. (S)		NS	0.105	0.044	NS	0.311	0.106
N x S		NS	0.102	NS	NS	NS	NS

Concerning the effect of sulphur, Data in table (2) showed also that root diameter and its weight were significantly affected by sulphur foliar treatments, whereas insignificant increase was detected between root diameter for both growing

seasons and root weight of the 2nd season between plants which sprayed once (S1) and those of control plants (S0) and sprayed the plants twice or three time gave insignificant difference in diameter or weight of root of both growing seasons. Both treatments (S2 and S3) significantly increased root diameter by 0.34 and 0.40 cm in 1st season and by 0.40 and 0.40 cm in the 2nd season respectively, compared with control treatment (S0). The corresponding increase in root weight were 0.12 and 0.13 kg for 1st season and 0.13 and 0.16 kg for the 2nd season respectively. Similar results were obtained by Moustafa, Zeinab *et al* (2006). Root diameter of sugar beet plants in the 1st season was significantly affected by the interaction between nitrogen and sulphur fertilization, thus the highest values of root diameter resulted from plants received 120 kg N/fed and spraied twice (S2) or three times (S3) by sulphur. In thise respect, Moustafa, Shafika *et al* (2005) and Awad Alla *et al* (2007) found a positive and significant effect on root growth traits due to interaction between N and S fertilization.

2- QUALITY OF ROOT JUICE

Juice quality measurement of sugar beet roots in terms of total soluble solids (TSS), sucrose and purity% as affected by nitrogen fertilizer and frequency of foliar spray with sulphur as well as their interaction are presented in Table (3).

Data given indicated that nitrogen fertilizer had a significant effect on juice quality in both seasons. Fertilizing sugar beet plant by 90 kg/fed significantly increased the value of quality in 1st season, however, adding 60 kg/fed in the 2nd season was enough to produce the highest values of TSS, sucrose%, while, 90 kg N/fed was still the suitable rate to attain the highest value of purity% in the 2nd season. On the other hand, increasing N fertilizer up to 120 kg/fed significantly decreased TSS%, by 0.30 and 1.0% compared with 60 and 90 kg N/fed respectively. The corresponding decrease values were 0.4 and 1.7% for sucrose and 3.4 and 4.7% for purity%. Data of the 2nd season showed that the increase nitrogen level from 60 to 90 kg/fed significantly increased TSS and sucrose% while increase nitrogen level to 120 kg/fed decreased TSS and sucrose%. Purity% was significantly decreased in root beet juice in plants fertilized by 60 or 120 kg/fed compared to that of 90 kg/fed. These results are in agreement with those by Moustafa, Zeinab *et al* (2000), Azzazy (2004) and Moustafa, Shafika *et al* (2005). On the other hand Ouda, Sohier (2002) stated that sucrose and TSS% were not significantly affected by nitrogen level.

Table 3. Effect of nitrogen and sulphur fertilizations on root juice quality of sugar beet for two growing seasons (2006/2007) and (2007/2008)

Nitrogen (Kg/fed)	No. of sulphur application	2006/2007 Juice quality %			2007/2008 Juice quality %		
		Total soluble solids (TSS)	Sucrose	Purity	Total soluble solids (TSS)	Sucrose	Purity
60	S0	19.9	16.4	82.00	18.2	15.1	83.00
	S1	19.6	16.0	81.90	19.2	14.8	77.20
	S2	19.3	15.8	81.70	19.5	15.2	78.00
	S3	19.1	15.4	81.55	19.3	15.2	78.50
	Mean	19.5	15.9	81.79	19.1	15.2	79.18
90	S0	20.7	17.6	85.10	19.3	16.2	83.30
	S1	19.9	16.8	84.50	18.3	15.2	81.00
	S2	20.1	16.3	81.40	18.3	14.8	80.70
	S3	20.0	16.0	80.20	17.3	14.6	84.50
	Mean	20.2	16.7	82.80	18.3	15.2	82.50
120	S0	19.3	15.5	80.00	17.4	14.2	81.60
	S1	19.2	15.3	78.90	17.0	13.6	80.70
	S2	19.1	14.9	77.80	17.2	13.6	79.10
	S3	19.0	14.4	77.80	17.0	13.2	77.60
	Mean	19.2	15.0	78.10	17.1	13.7	79.75
Means of sulphur	S0	19.9	16.5	82.40	18.3	15.2	82.80
	S1	19.5	16.0	81.80	18.1	14.5	79.60
	S2	19.5	15.7	80.30	18.3	14.5	79.30
	S3	19.3	15.3	78.80	18.2	14.3	80.20
LSD at 5%							
Nitrogen levels (N)		0.138	0.344	1.221	1.002	0.562	2.139
Sulphur spray No. (S)		0.312	0.199	1.545	NS	0.443	2.301
N x S		NS	NS	NS	NS	NS	NS

Results obtained in Table 3 show that the various juice quality measurement negatively and statistically affected by spraying treatments of sulphur, except TSS% in the 2nd season, the differences were not enough to reach the level of significance. Also, it could be noted that check treatment was more effective on juice quality measurement than the others treatments. In this respect of the effect of sulphur on quality of sugar beet, discrepant results were obtained by Mostafa, Zeinab *et al* (2006) and Awed Allah *et al* (2007).

The effect of interaction between nitrogen fertilization and sulphur spraying was insignificant on the previous traits in both seasons, Moustafa Shafika *et al* (2006) indicated that application of 90 kg N/fed with spray sulphur at 8 cm sulphur/L gave the highest sucrose content in beet juice.

3-Chemical analysis of root

A) Nitrogen, Phosphorus, Potassium and sulfate concentrations

Data in Table 4 show the effect of nitrogen and sulphur fertilization and their combination on N, P, K, and SO_4% in root beet at harvesting time for two growing seasons.

It can be noticed a gradual increase in N, P, K and SO_4 concentation with increasing nitrogen level (except K% for the 1st season). This increases were more evidence with N% than other elements such effect may be due to that N dressing enhanced the uptake of minerals which finally reflected to better growth of plants as discriped before. The same results were obtained by Moustafa, Zeinab *et al* (2000), Radha *et al* (2001) and Moustafa, Shafika *et al* (2005).

Table 4. Effect of nitrogen and sulphur fertilization on N, P, K and SO4% of sugar beet root for both growing seasons.

Nitrogen (Kg/fed)	No. of sulphur application	2006/2007				2007/2008			
		N%	P%	K%	SO_4%	N%	P%	K%	SO_4%
60	S0	1.93	0.180	1.100	0.250	1.030	0.130	0.990	0.210
	S1	2.10	0.180	1.150	0.250	1.280	0.160	0.980	0.290
	S2	2.03	0.160	1.150	0.290	1.260	0.160	1.090	0.410
	S3	2.03	0.130	1.150	0.370	1.460	0.180	1.110	0.480
	Mean	2.023	0.163	1.138	0.290	1.258	0.158	1.043	0.348
90	S0	2.025	0.220	1.100	0.220	1.290	0.170	1.110	0.220
	S1	2.015	0.240	1.190	0.280	1.450	0.200	1.230	0.320
	S2	2.036	0.250	1.220	0.310	1.430	0.190	1.280	0.560
	S3	2.035	0.220	1.240	0.500	1.500	0.220	1.270	0.630
	Mean	2.278	0.233	1.188	0.328	1.418	0.190	1.223	0.433
120	S0	2.39	0.200	1.130	0.250	1.610	0.200	1.200	0.260
	S1	2.35	0.260	1.140	0.270	1.550	0.200	1.270	0.440
	S2	2.45	0.280	1.210	0.500	1.650	0.210	1.290	0.590
	S3	2.48	0.280	1.270	0.730	1.660	0.220	1.290	0.750
	Mean	2.418	0.255	1.188	0.438	1.618	0.208	1.263	0.511
Means of sulphur	S0	2.190	0.200	1.110	0.240	1.310	0.167	1.100	0.230
	S1	2.200	0.227	1.160	0.267	1.427	0.187	1.160	0.350
	S2	2.280	0.230	1.930	0.367	1.447	0.187	1.220	0.520
	S3	2.87	0.210	1.220	0.534	1.540	0.200	1.223	0.870

Regarding S effect, data in Table (4) indicate that sulphur foliar application increased N, P, K and SO_4 concentration in sugar beet root as compared with the control (water spray). It can be noticed also, that the N% and SO_4% for both growing seasons as well as K% for the first season were gradually increased with increasing S foliar spray number,from one to three , while, the highest concentration for P in the 1st season and K in the 2nd one were found with twice foliar spray of sulphur. In this respect Radha *et al* (2001) and Moustafa, Shafika *et al* (2005) stated that the foliar application with sulphur has a positive effect in absorption of N,P,K and So_4 by sugar beet plants.

As for the interaction effect of nitrogen level and sulphur treatments on N,P,K and SO_4 % in sugar beet root it was noticed that the highly of concentration of N and SO_4 for two growing seasons and K for the first season were obtained with plants which received 120 kg N/fed and sprayed by three times with sulphur solution. However three time application with sulphur did not show any apparent differ on P% of both growing seasons and K% of the second season when compared with twice spray under level of 120 kg N/fed.

B-Amino acids

Results of chemical analysis for assessment amino acids as mg /100 gm in beet root (on dry matter basis) as affected by nitrogen level and sulphur foliar spray number as well as their interaction are presented in Table 5. In general, increase nitrogen level from 60 to 90 and 120 kg/fed led to increase (by different degree) in all amino acids concentration (except cystein). Those results are supported by the finding of Moustafa, Zeinab *et al* (2000) and Moustafa, Shafika *et al* (2005).

Table 5.

Nitrogen (kg/fed)	No. of sulphur application	1 ARG	2 ASP	3 CYS	4 GLY	5 GLU	6 HTS	7 LYC	8 MET	9 PRO	10 SER	11 THR	12 VAL
60	S0	70	215	43	136	328	121	107	50	170	160	115	140
	S1	74	210	43	141	320	88	105	54	170	136	112	146
	S2	66	214	42	146	327	112	99	60	176	130	112	140
	S3	63	218	43	144	326	113	99	60	180	116	115	140
	Mean	68	214	43	142	325	108	103	56	174	136	114	142
90	S0	77	219	46	150	329	116	115	66	178	167	120	158
	S1	70	219	46	143	334	125	120	69	185	155	120	154
	S2	70	219	50	139	333	120	107	73	185	110	120	162
	S3	66	216	51	140	323	120	109	79	190	116	117	160
	Mean	71	218	48	143	329	120	113	72	185	142	119	159
120	S0	78	219	40	165	330	132	140	70	179	180	130	180
	S1	78	220	40	152	322	132	140	68	182	150	135	173
	S2	71	218	50	155	330	130	120	78	196	133	116	166
	S3	60	219	53	135	340	130	100	82	198	109	106	167
	Mean	72	219	46	152	331	131	125	75	189	143	122	172
Means of sulphur	S0	75	218	43	150	329	123	121	62	176	176	122	159
	S1	74	216	43	154	329	115	122	60	179	147	122	158
	S2	69	217	47	147	330	121	109	70	186	124	116	156
	S3	63	218	49	140	330	121	103	74	189	114	113	156

1) Arginine 2) Aspartic 3) Cystein4) Glycine5) Glutamic 6) Histidine
7) Lycine 8) Methionine 9) Proline 10) Serine 11) Threlonine 12) Valine

Concerning sulphur effect on the individual amino acids concentration, results given in Table(5) revaled that increasing spray number by sulphur solution increased some amino acids such as Cystein, Methionine and Prolin, while, decreased Arginine, Glycine, Lycine, Serine, Thrionine and Valine. Sulphur fertilization had no clear effect on the accumulation of the other amino acids. These finding are in according with the results of Thomas *et al* (2000) and Moustafa, Shafika *et al* (2005).

In was mentionable that the interaction between nitrogen and sulphur application had no evident effect on concentration of amino acids, further more an inconstant trend was selected by analysis of sugar beet. Similar results were obtained in the 2nd season with approximately the same trend.

4-Root and sugar yield

A) Root yield

Results recorded in Table 6 clearly indicate that nitrogen fertilizer levels and sulphur foliar spray number as well as their interaction had significant effect on root yield for both growing seasons.

It can be noticed that increasing N level from 60 kg to 90 kg/fed markedly and significantly increased root yield for both growing seasons, whoever, eventually further N rate to 120 kg/fed significantly and insignificantly increased root yield of the first and the second growing season respectively.

In first season highest level of nitrogen fertilization (120 kg/fed) increased root yield by 11.15 and by 5.975 ton/fed compared with levels of 60 and 90 kg/fed respectively.

Table 6. Effect of nitrogen and sulphur fertilizers on root and sugar yield (tons/fed) for both growing seasons.

Nitrogen (Kg/fed)	No. of sulphur application	2006/2007 Yield (tons/fed)		2007/2008 Yield (tons/fed)	
		Root	Sugar	Root	Sugar
60	S0	24.56	3.30	24.00	2.860
	S1	24.70	3.20	26.40	3.100
	S2	25.96	3.30	28.60	3.430
	S3	27.23	3.33	28.97	3.500
	Mean	25.612	3.282	26.992	3.222
90	S0	28.76	4.10	32.90	4.200
	S1	28.90	3.96	34.56	4.170
	S2	31.66	4.13	35.73	4.160
	S3	33.83	4.36	36.63	4.360
	Mean	30.787	4.160	34.955	4.222
120	S0	35.63	4.13	36.60	4.060
	S1	36.93	4.46	36.80	3.830
	S2	37.06	4.36	37.03	3.860
	S3	37.43	4.43	37.13	3.760
	Mean	36.762	4.342	36.890	3.877
Means of sulphur	S0	29.650	3.976	31.166	3.740
	S1	30.176	3.873	32.586	3.700
	S2	31.56	3.963	33.786	3.816
	S3	32.83	.973	34.243	3.840
LSD at 5%					
Nitrogen levels (N)		1.191	0.227	2.222	0.413
Sulphur spray No. (S)		0.558	NS	0.858	NS
N x S		0.559	0.225	1.811	0.168

The corresponding increases were 9.898 and 1.895 ton/fed for the 2nd season. Such increases may be due to encourage effect of highest level of N on the previous trails of root growth as mentioned before (Table 2). These results are in full agreement with the results obtained by Ouda, Sohier (2002), Azzazy (2004), Moustafa, Shafika *et al* (2005) and Awad Allah *et al* (2007).

Concerning the effect of foliar spray with sulphur on root yield, it was noticed (Table 6) that sulphur foliar spray three times in both seasons in addition twice in the second season significantly increased root yield compared to other S-treatments.S2 and S3 treatments increased root yield by 1.91and 3.18 ton /f compared with S0 treatment in first season. The corresponding increases reached to 2.62 and 3.078 toN/f in the second season.

This increases may be attributable to enhanced influence of sulphur fertilization on root diameter and its weight (Table 2).

These finding confirmed the previous reports of Popovic *et al* (1996), El Adl (2002), Nemeat Allah (2005), Moustafa, Zeinab *et al* (2006) and Awad Allah *et al* (2007). On the other hand, Ouda, Sohier (2002) stated that the root yield was significantly decreased by adding sulphur fertilizer.

The combination of nitrogen and sulphur fertilization was also had a significant effect on root yield for both growing seasons. Data (Table 6) of the 1st season exhibited significant increase in root yield when the plants received 120 kg N/fed with sulphur foliar spray by all times comparing with another treatments. While data of the second season indicated that highest root yield values (without significant difference) were obtained when sugar beet plants recived 120 kg N/f only or with combination of all times of sulphur foliar spray as well as when using 90 kg N/f combined with twice or three times by sulphur foliar spray. Similar results were found by Moustafa, Shafika *et al* (2005) While Awad Allah *et al* (2007) stated that insignificant interaction effect between nitrogen fertilizer levels x elemental sulphur levels with regard to root yield of sugar beet.

B) Sugar yield

Data in Table 6 indicate that sugar yield significantly increased as nitrogen level increased from 60 to 90 kg N/fed, such increases were 0.878 and 1.0 ton sugar/fed in both seasons respectively. While increasing N level from 90 to 120 kg/fed had insignificant effect on sugar yield, although it increased sugar yield by 0.182 to N/fed in the 1st season but decreased sugar yield by 0.345 in the 2nd season .

This finding was attributed to decrease sucrose% with increasing N level to 120 Kg/fed (Table 3). The aforementioned results are in the same trend with those obtained by Moustafa, Zeinab, *et al* (2000), Moustafa, Shafika, *et al* (2005) and Awad

Allah, *et al* (2007). They reported that newly cultivated sandy soil increasing the applied dose of nitrogen over 90 kg/fed in decreased the sugar yield . While Ouda, Sohier (2002) founded that sugar yield tons/fad. Was increased by applying N up to 120 kg/fed it can be notice also, Sugar yield for both growing seasons was increased with two or three times foliar spray with sulphur (S2 and S3) but those increases were insignificant comparing with S1 and S2 treatment. In this respect Nemeat Alla (2005), Moustafa, Shafika, *et al* (2005), Moustafa, Zeinab, *et al* (2006) and Awad Allah *et al* (2007). They recorded that there was a significant difference among sulphur levels on sugar yield of sugar beet.

As regard of the interaction between nitrogen and sulphur on sugar yield, data in Table (6) show that the highest sugar yield ton/fed (without significant difference) were obtained for the 1st season by treatments of 120 kg N/fed with all sulphur foliar spray times (S1, S2 and S3) as well as 90 kg N/f with applying three time spray S3 with sulsion of sulphur, Results of the 2nd season indicated that 90 kg N/ed in combination sprayed three time by sulphur (S3) treatment only significantly increased sugar yield compared with the other interaction treatments. Similar result was obtained by Moustafa, Shafika, *et al* (2005) where as Ouda, Sohier (2002) founded a significant decrease in sugar yield with each N increment when the high S level was used on the other hand Awad Allah *et al* (2007) found insignificant interaction effect between nitrogen levels x elemental sulphur levels with regard to sugar yield of sugar beet.

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استجابة بنجر السكر للتسميد النيتروجيني والرش بالكبريت في مصر الوسطى

محمود سيد حسن عثمان١ ، منى مكرم شحاته٢

١. قسم المعاملات – معهد بحوث المحاصيل السكريه – مركزالبحوث الزراعيه – الجيزة.

٢. قسم الفسيولوجي والكيمياء – معهد بحوث المحاصيل السكريه – مركز البحوث الزراعيه – الجيزة.

اجريت تجربتان حقليتان في موسمي ٢٠٠٦/ ٢٠٠٧ و٢٠٠٧/٢٠٠٨بمحطه بحوث ملوي محافظة المنيا لدراسة تاثير معدل التسميد النيتروجيني (٦٠ و٩٠ و١٢٠ كجم/فدان) وتكرار الرش بمحلول كالسيوم بولي سيلفيد كسماد ورقي كبريتي (مره ومرتين وثلاثه) وتداخلاتهما علي بنجر السكر صنف (ديسبرس بولي ن). واوضحت النتائج مايلي:

– زيادة معدل التسميد النيتروجيني حتي ١٢٠ كجم/فدان ادت الي زياده معنويه لطول وسمك والوزن الطازج للجذر ايضا محصول الجذور وتركيز النيتروجين والفسفور والبوتاسيوم والكبريت والاحماض الامينيه (ماعدا السيستين حيث زاد معنويا بمعدل ٩٠كجم/ فدان مقارنة ب ١٢٠ كجم/فدان). بينما ادي التسميد بمعدل ٩٠ كجم/فدان الي زياده معنويه لصفات الجوده (النسبه المئويه لكل من المواد الصلبه الكليه والسكروز والنقاوه) ايضا لمحصول السكر.

– ادي تكرار رش نباتات بنجر السكر بمحلول التسميد الكبريتي سواء مرتين او ثلاثه الي زياده معنويه في الوزن الطازج والسمك ومحصول الجذور وتركيز النيتروجين والفوسفور والبوتاسيوم والكبريت بينما زاد تركيز بعض الاحماض الامينيه وقل تركيز البعض الاخر. مع نقص معنوي للجوده وعدم التاثير علي محصول السكر.

– ادت معاملة التسميد النيتروجيني بمعدل ٩٠ كجم/فدان مع الرش ثلاث مرات بمحلول التسميد الكبريتي الي تسجيل اعلي زياده في كل من محصول الجذور والسكر مع ملاحظة عدم وجود اختلافات معنويه مع تأثير بعض المعاملات الاخري.