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EFFECT OF PLANTING DATE AND SULPHUR FERTILIZER ON YIELD AND QUALITY OF SUGAR BEET UNDER NEWLY RECLAIMED SOILS

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ABSTRACT

Two field experiments was conducted at El-Serw Agricultural Research Station, Damietta Governorate, Egypt during 2012/2013 and 2013/2014 seasons. The objective of this investigation was aimed to study the effect of three sowing dates (mid September , first October and mid October) and soil application of sulphur fertilizer in the form of Calcium poly sulfide ($CaSO_4$ 30% sulphur) at the levels of (zero, 100 and 200 kg $CaSO_4$/fed., mixed with soil) which were applied at age 45 and 75 day, for Soltan cultivar.

A split plot design with four replicates was used. The main plots were assigned to sowing dates, whereas, soil application with $CaSO_4$ were distributed in the sub plots.

The results can be summarized as follows:-

1- Lating planting sugar beet until mid October due to significant increase in root dimension and root fresh weight/plant in addition, applied sulphur at rate (200 kg CaSO4 30% sulphur) take the same trend of lating planting date for the same characters.

2-Significant increase was obtained in quality characters as (TSS, Sucrose and Purity %) in both seasons resulted from planting at mid October and addition 200 kg calcium poly sulphur.

3- The highest values of all characters under study resulted from addition 200 kg sulphur for lat planting date in both seasons.

4- Significant decrease in values of impurities (K, Na and α-amino N.) were found resulted from lat planting up mid October and fertilization with 200 kg sulphur in both season.

INTRODUCTION

Under the limited cultivated area and the scarce water resources there are many attempts to increase vertically the productivity of the cultivated unit area. It is well known that the productivity of any crop broadly depends upon the used varieties and fertilization program. Egyptian Government imports large amounts of sugar, i.e. about 1.10 million ton, every year to face the rapid increase of population. Sugar beet plays a prominent role for sugar production, about 37.27% of locally sugar production. (CCSC, 2010).

There is a great need to find out the proper technical recommendations for improving the productivity and quality of sugar beet under Egyptian conditions. Because the Egyptian soils suffer from a high pH values, the availability of P, K and micronutrients is reduced . The use of sulphur might help in decreasing soil alkalinity during sulphur biological oxidation. In this subject, El- Kammah and Ali (1996) and Hashem *et al* (1997) indicated that yields of roots and sugar were significantly increased with increasing levels of applied sulphur.

There are many factors affecting yield and quality of sugar beet as nutritional status as well as some agro practices application, i.e., fertilization, sowing dates and methods. With respect to sowing dates, Allam *et al*. (2005) showed that the highest value of root and sugar yields/fed were obtained when sugar beet sowing date at 1st October. Ismail *et al.* (2006) found that early sowing date at 1st October led to significant increase in root fresh weight, sucrose%, purity%, sugar and root yields/fed as compared with delay sowing dates on 15th October and 1st November. El-Geddawy *et al*. (2007) showed that sowing sugar beet early at 15th September significantly attained the higher value of root length, diameter, root fresh weight/plant, root and sugar yields/fed than at late sowing date on 15th October. Mosa (2009) studied three sowing dates on 15th September, October and November. He found that early sowing date on 15th September significantly increased root length, diameter, root and sugar yields/fed as compared with delay sowing date on 15th October or November. El-Hosry *et al*. (2010) revealed that root length and root yield/fed were significantly increased with sowing date on 15th October as compared on 15th Sepember and 15th November.

There is a great need to find out the proper technical recommendations for improving the productivity and quality of sugar beet under Egyptian conditions. Because the most Egyptian soils suffer from a high pH values particularly newly reclaimed soil, the availability of P, K and micronutrients is reduced. The use of sulphur might help in decreasing soil alkalinity during sulphur biological oxidation. 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. Draycott (1972) and Thomas *et al*. (2000) stated that sulphur is a constituent element of some amino acids, namely Cystein and Methionine and it is involved in synthesis of chlorophyll, 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. In this subject, El-Kammah and Ali (1996) and Hashem *et al.* (1997) indicated that yields of roots and sugar were significantly increased with increasing levels of applied sulphur. Root, top and sugar yields of sugar beet increased significantly with increasing potassium fertilizer rate up to 48 kg K_20/fed (El-Kassaby *et al* 1991 and El-Ramady 1997), Sobh *et al* 1992 and Soltan 1999) stated that K, Na and α- amino N contents of fresh roots increased with increasing K level till 48 kg/fed .

Also, Nemeat Alla (2005) reported that sulphur fertilizer level at 300 kg/fed led to significant differences in root growth, i.e. length and diameter, as well as root yield/fed as compared with the other two levels 100 and 200 kg/fed in both seasons. Ouida, Sohier (2002), Shafika *et al.* (2005), Zeinab *et al.* (2006) and Awed Allah *et al.* (2007) reported that response degree of growth, quality, chemical composition and yield of sugar beet differ according to the level of sulphur fertilization. Osman and Shehata, Mona (2010) foliar spray with sulphur in the form of Calcium Poly Sulfide (30%) at concentration of 6 cm/l which was applied once, twice and three times at 70, 85 and 90 days after sowing in addition to foliar spray with distilled water as control. The

results observed that there were significant increases in root diameter, root fresh weight/plant, root yield/fed and accumulation N, P, K, and SO_4. While, root quality significantly decreased.

Ferweez *et al*. (2011) indicated that sulphur fertilization level at 200 kg/fed. had a significant increase on root diameter, pol%, Na content, α-amino nitrogen, sugar recovery%, quality index and sugar yield/fed in the two growing seasons.

Awad *et al* (2013 c) to study the effect of three levels of sulphur, i.e. zero, 125 and 250 kg/fed. and three levels of potassium fertilizer (12, 24 and 48 kg K_2O/fed.) on productivity and quality characteristics of sugar beet. A split plot design with four replications was used . The interaction between sulphur and potassium levels had a significant influence on root yield in the 1st season and their combined for recoverable sugar yield to level of significance. Applying (250 kg S/fed.) for sugar beet is preferable to get the highest root and recoverable sugar yields/fed of sugar beet with 24 kg K_2O/fed. to get the highest value of quality index. Under the experiment conditions, applying 250 kg sulphur with 24 kg K_2O/fed. is preferable to obtain the highest root and recoverable sugar yields/fed of sugar beet and the highest quality index .

The aim of this study was aimed to find out the suitable sowing dates and level of $CaSO_4$ as soil application to induce high quality and yields/fed. of sugar beet plants under newly reclaimed soil conditions.

MATERIALS AND METHODS

Two field experiments was conducted at El-Serw Agricultural Research Station, Damietta Governorate, Egypt during 2012/2013 and 2013/2014 seasons. This investigation was aimed to study the effect of three sowing dates (mid September , first October and mid October) and soil application of sulphur fertilizer in the form of Calcium poly sulfide ($CaSO_4$ 30% sulphur) at the levels of (zero, 100 and 200 kg $CaSO_4$/fed., mixed with soil), which were applied at age 45 and 75 days, from sowing (Soltan) cultivar. The mean of temperature degree and relative humidity% in both seasons are presented in Table 1. The preceding crop was maize in both seasons.

Table 1: Mean of temperature degree and relative humidity% in both seasons.

Year	2012-2013 season						2013-2014 season					
Months	Temperature (C°)			Relative humidity%			Temperature (C°)			Relative humidity%		
	Max	Min	Aver	Max	Min	Aver	Max	Min	Aver	Max	Min	Aver
September	31.5	19.5	25.5	84.0	33.4	58.7	32.5	19.7	26.1	81.6	28.3	54.9
October	32.3	18.6	25.45	85.3	30.0	57.6	31.4	19.5	25.4	80.9	27.7	54.3
November	27.4	15.3	21.35	88.2	36.0	62.1	28.4	15.3	21.8	81.6	29.8	55.7
December	22.2	9.7	15.95	80.1	36.8	58.4	23.1	9.7	16.4	81.9	35.4	58.6
January	21.3	9.4	15.35	81.7	35.2	58.4	21.8	9.1	15.4	78.4	33.6	56.0
February	23.4	10.0	16.7	84.5	35.9	60.2	22.7	7.9	15.3	86.4	35.4	60.9
March	26.2	11.7	18.95	81.5	33.0	57.2	24.9	10.6	17.7	78.6	27.8	53.2
April	28.5	13.4	20.95	80.6	23.0	51.8	30.4	13.6	22.0	76.8	24.6	40.7
May	30.5	14.5	22.5	79.3	22.0	50.6	31.8	14.2	23.0	75.7	22.8	49.2

Source: Agro-meteorological station, Agric. Res. Center, Giza, Egypt.

A split plot design with four replicates in both seasons was used. The main plots were assigned to sowing dates, whereas, soil application with $CaSO_4$ in the sub plots. Sub plot area was 12.25 m^2 consisted of 5 ridges of 3.5 m long at 70 cm apart and spacing between hills 20 cm.

Table 2: Mechanical and chemical analysis of soil.

Particle Size distribution				
Coarse sand %	**Fine sand %**	**Silt %**	**Clay %**	**Texture**
1.55	10.70	22.4	85.0	Clayey

Characters / Treatments	OM %	Available N ppm	Available P Ppm	Available K ppm	PH Of soil Susp 1:25	Total dissolved salts	
						%	mmhos /cm
Burning	2.66	81.4	40.0	607.3	8.4	0.21	0.655
Without Burning	2.94	84.3	33.3	624.0	8.7	0.17	0.542

Some physical and chemical analysis of the experimental soils according to Page (1982) in Table 2. Nitrogen fertilizer at the level of 120 kg/fed. in the form of ammonium nitrate (33.5% N) was applied in four equal doses, the first was applied after thinning and the others was applied at 2-weeks interval after the first application. Phosphorus fertilizer level at the rate of 45 kg/fed. in the form of calcium super phosphate (15.5% P_2O_5) was added during land preparation. Potassium fertilizer level of 24 kg/fed. in the form of potassium sulfate (48% K_2O) was applied in four equal doses with nitrogen fertilizer. Other agricultural practices for sugar beet field were carried out as recommended by Sugar Crops Research Institute.

Recorded data:

At harvest time (210 days from planting) the three guarded ridges were topped: A sample of 10 roots was randomly taken and the following traits were recorded:

1-Root length (cm). 2- Root diameter (cm). 3- Root fresh weight (g/plant). 4- Total soluble solids (TSS%) was determined by using Hand refractometer.5- Sucrose% was determined according to the procedure of Le Docte (1927). 6- Purity percentage: It was estimated according to the following equation

Purity %= 99.36-{14.27(V1+V2+ V 3/ V 4)}

Where: V1=Na , V2= K, V3= α-amino-N, V4= sucrose %. (Na, K and α-amino-N) were determined as milliequivalent/100 g beet.

7- Root yields (ton/fed.) was determined on the whole plot basis were harvested, topped and weighed to determine root yield.

8- Sugar yield which was calculated by multiply root yield (ton/fed.) x sucrose%. Data statistically analyzed according to Snedecor and Cochran (1981).

RESULTS AND DISCUSSION

Root growth

Root length, root diameter and root fresh weight:-

Data presented in Table 3 showed that root growth in both season take the same trend, significant increased in values of these traits with lating

planting dates from mid September till mid October. These significant increase due to available good chance for growth from optimum temperature for growth and accumulation of photo syntheses substances which gave maximum root dimensions and root fresh weight.

Concerning the effect of sulphur on root growth traits root length, root diameter and root fresh weight data in Table 3 cleared that with increasing sulphur fertilizer rates from zero to 200 kg S/fed. to sugar beet plants caused significant increase in values of root growth this was true in both seasons.

Table 3: Effect of sowing dates on growth, quality traits and yields at harvest during 2012/2013 and 2013/2014 seasons.

2012/2013 season								
Traits / Treatment	Root growth traits.			Juice quality %.			Yields (ton/fed.).	
	RL	RD	RFW	TSS	S	P	R	S
Planting **date**								
15/9	28.6	10.3	1.11	20.75	16.45	81.20	27.84	4.58
1/10	31.3	11.7	1.23	21.65	17.56	83.32	29.65	5.20
15/10	34.5	12.9	1.76	22.40	18.12	84.64	32.45	5.88
F. Test	**	**	**	**	**	**	**	**
LSD at 5%	1.23	0.44	0.28	0.12	0.84	0.76	0.65	1.02
Sulphur($CaSO_4$ kg/fed.).								
Zero	24.30	9.85	1.08	19.84	16.34	74.32	24.84	4.06
100	30.70	11.24	1.42	21.37	17.25	81.87	28.67	4.94
200	33.45	12.87	1.87	22.95	18.07	83.45	32.78	5.92
F. Test	**	**	**	**	**	**	**	**
LSD at 5%	3.18	0.97	0.64	1.04	0.87	1.32	2..11	1.04

RL= Root length (cm), RD = Root diameter (cm), RFW = Root fresh weight Kg/plant, TSS = Total soluble solids%, S= Sucrose%, P = Purity%, R. = Root yield and S = Sugar yield(ton/fed.).

These results due to the important role of sulphur in improving properties of soil to absorption more nutrients for growth and gave maximum growth. Similar results were obtained by El-Geddawy *et al* (2007), El-Hosry *et al* (2010) , Awad *et al* (2012) and Awad *et al* (2013 a, b and c).

Effect of soil application with calcium poly sulfide $CaSO_4$ (30% sulphur):

Juick quality

Total soluble solids, sucrose and purity %.

All of above mentioned characters significantly increased with lating planting dates from mid September to mid October in both seasons in Table 3.The superiority which resulted from planting date due to giving suitable environmental conditions to good growth, accumulation sucrose in roots and decrease impurities to gave extent purity for juice of root. Concerning the effect of sulphur fertilizer on juice quality of root, with increasing the rates of sulphur nutrient to soil gave a good moderation to soil solution and increased most of macro and micro elements to plants and decreased the impurities in roots. Similar findings were found by Ouida, Sohier, (2002), Shafika *et al* (2005), Awad Allah and Ahmed (2007) and Awad *et al* (2013 c).

Yields

1-Root and sugar yields ton/fed.

Table 3 show that root and sugar yields significantly increased with delaying planting date on mid October in both seasons. With lating planting

date gave more suitable conditions for increasing root size and sucrose accumulation in root which gave the highest root and sucrose yields. Allam *et al (*2005) reported that late planting in first October gave the highest root and sugar yields. Also, Awad *et al* (2013 c) found the same trend.

Application of (200 kg S/fed.) exhibited significant differences in values of root and sugar yield compared to zero addition from sulphur which gave the lowest one. Sulphur fertilizer controlled pH of soil and root lake sufficient nutrients for maximum root and sugar yields. These results are in accordance with those obtained by Ferwez *et al* (2011) ,Awad *et al* (2012) and Awad *et al* (2013 a, b and c).

Table 4: Effect of sulphur on roots growth, quality traits and yields/fed. at harvest during 2012/2013 and 2013/2014 seasons.

2013/2014 season								
Traits / Treatment	Root growth traits.			Juice quality %.			Yields (ton/fed.).	
	RL	RD	RFW	TSS	S	P	R	S
Planting date								
15/9	29.12	10.5	1.25	21.12	17.02	82.31	28.31	4.82
1/10	32.54	11.9	1.46	22.41	17.87	84.54	30.97	5.79
15/10	35.17	13.4	1.75	24.10	18.44	86.32	34.25	6.31
F. Test	**	**	**	**	**	**	**	**
LSD at 5%	1.32	0.51	0.02	0.31	0.91	0.84	0.77	1.10
Sulphur($CaSO_4$ kg/fed.).								
Zero	25.44	10.10	1.24	20.65	16.55	75.18	25.64	4.24
100	32.32	11.85	1.64	21.87	17.46	82.33	29.87	5.21
200	34.86	13.10	1.93	23.75	18.15	84.25	33.64	6.10
F. Test	**	**	**	**	**	**	**	**
LSD at 5%	1.54	0.43	0.21	0.65	0.77	1.18	1.97	0.84

RL= Root length (cm), RD = Root diameter (cm), RFW = Root fresh weight Kg/plant, TSS = Total soluble solids%, S= Sucrose%, P = Purity%, R. = Root yield and S = Sugar yield(ton/fed.).

Impurities

Sodium, potassium and α-amino N concerning the effect of planting date on impurities values in sugar beet root, data presented in Table 4 and 5 showed that lating in planting date from mid September to mid October caused to significant decrease in impurity content as potassium, sodium and α-amino N in roots.

These results are in accordance with those obtained by Awad *et al* (2013 c).

Concerning to the effect of sulphur fertilization on impurities in sugar beet root. Results indicated that with increasing sulphur fertilizer doses from zero to 200 kg S/fed. due to significant decrease in impurities contents, this was true in both seasons. These decrease in impurities reflected the beneficial role of sulphur to plants which represented in more growth and little impurities in plant. These results are harmony with those obtained by Osman and Shehata, Mona (2010) and Awad *et al* (2013 c).

Interaction effects:

Results in Table 6 and 7 found that the interaction between sowing dates and soil $CaSO_4$ application led to a significant effect on potassium content, sodium content,α-amino N content milliequa valents/100 gm beet, sucrose %, root and sugar yields ton/fed. in both seasons.

Table 5: Effect of sowing dates on potassium content, sodium content and α-amino N content harvest during 2012/2013 and 2013/2014 seasons.

Traits / Treatment	Na *		K *		α-amino N *	
	1st	2nd	1st	2nd	1st	2nd
15/9	6.31	6.00	1.58	1.46	2.13	2.10
1/10	5.88	5.70	1.43	1.50	1.89	1.85
15/10	5.79	5.63	1.30	1.26	1.82	1.79
F. Test	*	*	*	*	*	*
LSD at 5%	0.12	0.11	0.08	0.09	0.13	0.10
Sulphur($CaSO_4$ kg/fed.).						
Zero	6.02	5.74	1.50	1.40	2.00	1.95
100	5.73	5.65	1.37	1.26	1.75	1.78
200	5.46	5.55	1.21	1.20	1.68	1.69
F. Test	*	*	*	*	*	*
LSD at 5%	0.09	0.10	0.03	0.07	0.07	0.09

***(milliequivalent/100 g beet).**

Significant interaction effects were found between planting dates x sulphur fertilizer levels on sucrose %, root and sugar yields in both seasons in Table 7.

Table 6: Interaction between sowing dates and soil application with $CaSO_4$ in both seasons.

2012/2013 seasons.									
Traits	Na *			K *			α-amino N *		
Sulphur / Dates	Sulphur ($CaSO_4$ kg/fed.).								
	Zero	100	200	Zero	100	150	Zero	100	200
15/9	5.67	6.27	6.52	1.56	1.52	1.49	2.14	2.11	2.10
1/10	5.25	5.90	6.21	1.41	1.38	1.36	1.90	1.88	1.84
15/10	5.42	5.62	6.10	1.30	1.28	1.27	1.84	1.80	1.78
F. Test	*			*			*		
LSD at 5%	0.14			0.09			0.11		
2013/2014 season.									
15/9	5.54	6.14	6.47	1.51	1.46	1.43	2.07	2.04	2.06
1/10	5.21	5.78	6.13	1.37	1.31	1.29	1.77	1.76	1.81
15/10	5.36	5.46	6.02	1.24	1.22	1.22	1.78	1.77	1.74
F. Test	*			*			*		
LSD at 5%	0.16			0.11			0.12		

***(milliequivalent/100 g beet).**

Table 7: Interaction between sowing dates and soil application with $CaSO_4$ in both seasons.

2012/2013 seasons.									
Traits	Sucrose %			Root yield ton/fed.			Sugar yield ton/fed.		
Sulphur / Dates	Sulphur ($CaSO_4$ kg/fed.).								
	Zero	100	200	Zero	100	200	Zero	100	200
15/9	16.35	17.15	17.85	22.65	27.45	31.72	3.70	4.71	5.66
1/10	16.42	17.45	17.97	22.88	27.98	32.46	3.76	4.88	5.83
15/10	16.55	17.65	18.10	23.04	28.14	33.18	3.81	4.97	5.97
F. Test	*	*	*	*	**	**	*	*	*
LSD at 5%	0.17	0.21	0.14	0.23	0.31	0.64	0.07	0.09	0.12
2013/2014 season.									
15/9	16.41	17.26	17.87	22.87	27.94	31.88	3.75	4.82	5.70
1/10	16.55	17.56	18.00	23.10	28.21	32.87	3.82	4.95	5.92
15/10	16.62	17.70	18.24	23.46	28.76	34.08	3.90	5.09	6.22
F. Test	*	*	*	**	**	**	*	*	*
LSD at 5%	0.08	0.11	0.12	0.21	0.74	0.97	0.31	0.23	0.33

In respect to effect of interaction between planting date and sulphur fertilizer levels on sucrose %, maximum sucrose % was obtained (18.10 and 18.24 %) resulted from the interaction between planting date mid October and addition 200 kg S/fed. to plants in both seasons.

Concerning the interaction effect between planting date and sulphur fertilizer on root yield. Data collected in Table 7 showed that maximum root yields were obtained 33.18 and 34.08 ton/fed. resulted from delaying planting date to mid October and applied sulphur fertilizer up to 200 kg S/fed. in both seasons.As for effect of interaction between planting date and sulphur fertilizer on sugar yield in both seasons.

The interaction effect take the same trend in above two mention characters.

Planting late x sulphur level 200 kg S/fed. gave the highest values of sugar yield in both seasons 5.97 and 6.22 ton/fed. respectively.

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تأثير مواعيد الزراعة و التسميد بالكبريت على محصول وجودة بنجر السكر في الأراضي حديثة الاستصلاح

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أقيمت تجربتان حقليتان خلال الموسمين الزراعيين ٢٠١٢/٢٠١٣ و ٢٠١٣/٢٠١٤م بمحطة البحوث الزراعية بالسرو بمحافظة دمياط لدراسة تأثير ثلاثة مواعيد للزراعة وهى (منتصف سبتمبر، ألأول من أكتوبر ونصف أكتوبر) والتسميد بالسماد الكبريتي في صورة كالسيوم بولى سلفيد ٣٠% كبريت بثلاثة معدلات وهى صفر ، ١٠٠ ، ٢٠٠ كجم كالسيوم بولى سلفيد٣٠% /فدان مرتين بعد ٤٥،٧٥ يوم من الزراعة علي بنجر السكر صنف (سلطان).وقد استخدم التصميم قطع منشقة مرة واحدة حيث تم وضع مواعيد الزراعة في القطع الرئيسية- وفى القطع الشقية الأولى تم وضع معدلات السماد الكبريتي

وأوضحت النتائج ما يلي:-

١-أوضحت النتائج أن الزراعات المتأخرة حتى (نصف أكتوبر) حدثت زيادة معنوية في كلا من طول وقطر الجزر والوزن الغض للجذور في كلا الموسمين. كذلك كان لزيادة معدلات السماد الكبريتي من(صفر إلى ٢٠٠ كجم/فدان) أدى إلى نفس الاتجاه في الزيادة المعنوية للصفات السابقة في كلا الموسمين.

٢-أشارت النتائج ألي زيادة صفات جودة العصير (المواد الصلبة الذائبة الكلية- نسبة السكروز- النقاوة) زيادة معنوية في كلا موسمي الزراعة وذلك بالتأخير في مواعيد الزراعة حتى (نصف أكتوبر) وبزيادة معدل التسميد بالكبريت من صفر إلى ٢٠٠ كجم/فدان أدى إلى نفس الزيادة المعنوية في الصفات السابق ذكرها.

٣- أظهرت النتائج أن الزراعة المتأخرة وكذلك أكبر معدل للسماد الكبريتي (١٠/١٥، ٢٠٠ كجم كبريتات الكالسيوم ٣٠ %) أكبر القيم للصفات تحت الدراسة السابق ذكرها في موسمي الزراعة.

٤- أوضحت النتائج أنة انخفضت الشوائب في الجذور في كلا موسمي الزراعة وذلك بالتأخير في الزراعة وكذلك بزيادة معدل التسميد بالكبريت من صفر إلى ٢٠٠ كجم/فدان.

توصى هذه الدراسة باستخدام معدل التسميد بالكبريت من ٢٠٠ كجم/فدان ، والزراعة المتأخرة حتى منتصف أكتوبر للحصول على أعلى إنتاجية من وحدة المساحة لمحصول بنجر السكر تحت ظروف البيئية لمحطة البحوث الزراعية بالسرو بمحافظة دمياط.