RESPONSE OF SOME SUGAR BEET CULTIVARS TO PLANTING METHODS AND POTASSIUM FERTILIZER

Alaa, I. Badr
Sugar Crops Res. Inst., Agric. Res. Center, Giza, Egypt.

ABSTRACT

The present investigation was conducted on a clay soil through two field experiments at El-Hamoul area, Kafr El-sheikh Governorate, Egypt, in 2005/2006 and 2006/2007 seasons. Four multigerm sugar beet cultivars (*Beta vulgaris* L.) cv. namely, Ras Poly, Farida, Monto Bianco and Athos poly were cultivated to study the effect of planting method (manual and mechanical) and potassium fertilizer rate on yield and quality characteristics.

Potassium rates were (0, 24 and 48 K_2O/fed. as potassium sulphate 48% K_2O). Each rate was applied in one dose after thinning. Nitrogen and phosphorus were added at the recommended dose as ammonium nitrate (33.5% N) and super-phosphate (15.5% P_2O_5), respectively.

Mechanical planting resulted in a substantially increase in root and sugar yield in both seasons.

Farida cultivar significant exceeded Athos poly in root yield in the first season and sugar yield in both seasons. Monto Bianco and Farida cultivars did not differ significantly in root and sugar yields in the first season, only. Ras poly cultivar surpassed the other three cultivars in top yield in both seasons. Also, Farida cultivar produced the highest sucrose % in root juice in the two seasons.

Increasing potassium rate from 0 to 48 kg K_2O/fed. significantly increased sucrose % and sugar yield/feddan in the second season, only.

INTRODUCTION

In Egypt, sugar beet has become an important crop for sugar production. Recently efforts have been made to increase the productivity of sugar beet per unit area through planting high yielder cultivars and improving its agricultural practices. A good stand is the first perquisite for a good yield of sugar beet.

Sugar beet seed must be sown with great care and the drill must be well maintained and adjusted to suit the field conditions. It is critical to place the seed at the right depth, normally 2-3 cm, and with correct alignment..

Singh and Thakur (1979) stated that when sugar beet is planted manually, the required number of seeds on each hill is difficult to control and at some place more seeds are dropped than desired. This consumes more time and energy at the time of thinning and singling the plant.

Heyland (1985) found that when the drill was used to sow beet into a desiccated phacelia stand. Compared with conventionally sown crops on cultivated plots, beet sown with this drill showed similar or slightly higher sugar content.

Taieb (1997) concluded that the mechanical planting of sugar beet saved 33% of seeds rates compared with manual planting. The mean yield of sugar beet roots were 29.219 and 34.380 t/fed. for manual and mechanical planting, respectively. He added that the sugar percent in roots for manual planting was less than in those for mechanical planting.

Several studies pointed out that application of mechanical planting methods increased treatments per unit area, root yield, sugar percentage and sugar yield compared with manual planting methods (Mady, 1997, Mostafa *et al.*, 1998, Awad, 2000, Awad *et al.* (2004), Awad (2005), and Abd El-Salam (2008). These advantages are more uniformity to seed distributions over the area and created favorable conditions to plant growth.

Potassium is an essential element for plant growth not only in regard to its concentration in plant tissues but also with respect to its physiological and biochemical functions. Potassium is necessary for activating the starch synthetase enzyme (Nitoses and Evans, 1969). In adequate K supply results in accumulation of low molecular weight sugar and amino acids (Nowakowski, 1971). The highest uptake rate of K often being in the vegetative stage (Mengel and Kirkby, 1982, he also added that N is only fully utilized for crop production when K supply is adequate and that replacement of K^+ by Na^+ is possible especially in sugar beet.

Several studies cleared that potassium element is the most important factor in limiting sucrose percentages and sugar yield of sugar beet and its attributing variables. Lielah and Taha (1992) reported that 24 K_2O kg/fed. was recommended fertilizer treatment for raising root yield of sugar beet. Khalifa *et al.*, 1995 reported that root and sugar yields had significant and positive response to increment of K-rates up to 48 kg K_2O/fed.

The present investigation was carried out to compare some sugar beet cultivars for quality and yield characters under effect of planting methods and different potassium fertilizer rates.

MATERIALS AND METHODS

Two field trials, during 2005/2006 and 2006/2007 were conducted on a clay soil at Kafr El-Sharky village in El-Hamoul area, Kafr El-Sheikh Governorate, to study the effect of planting methods and different potassium fertilizer rates on yield and quality of four poly germ sugar beet varieties (*Beta vulgaris* L.) namely, Ras Poly, Farida Monto Bianco and Athos poly.

Mechanical and chemical analysis of soil samples taken to 30 cm depth in the experimental sites before soil preparation are given in Table 1.

Treatments were arranged in strip-split plot design with three replicates. The vertical plots were assigned to the sugar beet varieties, the horizontal plots to planting methods, the sub plot to potassium fertilizer rates. The planting methods were manual and mechanical planting methods. In manual planting method, seeds of sugar beet were sown manually in hills on one side of ridges 60 cm a part (traditional method). Seed number per hill were 2 or 3. In mechanical planting methods. Seeds of sugar beet were sown in hills 15 cm apart at the rate of one seed ball per hill on one side of ridges 60 cm apart by using Italian planter "Gaspardo" which consist of 4 drilling units work under vacuum, RBM 540.

The technical specification of the planter area as follows:

Type and model	: Gaspardo
Source of manufacture	: Italy
No of ridges	: Four
Ridge spacing (mm)	: 600-850
Weight (kg)	: 550
Working width (mm)	: 2000-3200
Metering devive	: Vertical

Potassium fertilizer in the form of K_2SO_4, (48% K_2O). K-rates were 0, 24, 48 kg K_2O/fed.; potassium fertilizer was applied one dose after two months from thinning. The sub plot size was 24 m^2 (5 x 4.8 m). Sowing took place on 5 October in 2005/2006 and 2006/2007 seasons, respectively. 30 days after sowing, thinning one plant per hill was done. Other cultural practices were done as recommended.

Table (1): Chemical analysis of the soil experimental area at the depth of 0-30 cm.

Characteristics	Seasons	
	2005/2006	20062007
pH (1: 5)	7.20	8.08
EC m mhas cm.	3.57	3.59
Available N ppm	15.11	16.00
Available P ppm	4.10	4.19
Available K ppm	393	401

Soil texture is heavy clay.

It was determined as average of ten guarded plants at harvest (at 200 days after sowing), root length and root diameter were determined as average of broad and narrow sides of root (cm). Root and top yields per plot transformed to metric tons per feddan. TSS% was determined in juice of roots with automatic refractometer at all sampling dates at harvest. Sucrose content in juice (or pol reading) of beet in each treatments was determined by an automatic sugar polarimeter (Saccharometer) as described by McGinnus (1971). Juice purity percentage (QZ) was calculated as the ratio between sucrose and total soluble solids (TSS) percentages in roots.

Sugar yield per feddan was calculated from root yield per feddan multiplied by sucrose percentage. The analysis of variance was carried out according to Gomes and Gomes 1984. Treatment means were compared by Duncan's Multiple Range Test (Duncan, 1955). All statistical analysis were performed using analysis of variance technique by means of ((MSTATC) computer software package.

RESULTS AND DISCUSSION

Four multigerm sugar beet varieties Ras Poly, Farida, Monto Bianco and Athos Poly were treated with planting methods and potassium fertilizer rates, to enhance their yield and quality characters for each variety.

1. Root length and diameter:

Data in Table 2 show no significant differences in root length and diameter at harvest between the planting methods.

Table (2): Root length and diameter (cm), root and top yield (ton/fed) of sugar beet as affected by planting method, varieties and potassium fertilizer in 2005/2006 and 2006/2007 seasons.

Characters / Factors	Root length		Root diameter		Root yield		Top yield	
	2005/06	2006/07	2005/06	2006/07	2005/06	2006/07	2005/06	2006/07
Planting method (P)	N.S	N.S	N.S	N.S.	*	*	N.S	*
• Manual	21.9	21.1	10.8	10.9	24.281 b	25.014 b	7.675	8.511 b
• Planter	22.4	22.7	10.8	11.4	28.978 a	28.125 a	8.497	9.333 a
Varieties (V)	*	N.S	*	N.S	*	N.S	**	*
• Ras poly	21.2 c	21.7	10.4 b	11.1	25.806ab	28.206	11.011 a	13.417 a
• Farida	22.8 ab	22.0	10.9 b	11.0	27.883 a	26.872	7.467 c	6.739 c
• Monto Bianco	21.6 bc	20.8	11.4 a	11.3	28.933 a	27.067	8.972 b	9.233 b
• Athos poly	22.9 a	22.8	10.8 b	11.1	24.189 b	27.039	4.900 d	6.300 c
Potassium rate (K)	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
• Control	22.1	22.0	10.8	11.1	26.967	27.416	7.954	9.171
• 24% K_2O	21.5	21.6	10.9	11.2	27.300	26.812	8.783	9.362
• 48 % K_2O	22.8	22.0	10.9	11.1	25.842	27.658	7.525	8.233
Interaction								
P x V	N.S	*	N.S	*	N.S	*	N.S	N.S
P x K	**	N.S	N.S	*	**	*	N.S	*
V x K	**	N.S	N.S	N.S	N.S	N.S	N.S	N.S
PVK	N.S	*	**	N.S	**	N.S	N.S	N.S

*, ** and N.S. indicate $P < 0.05$, $P < 0.01$ and not significant, respectively.
Means of each factor designed by the same letter are not significantly different at 5% level using Duncan's multiple range.

Varieties had a significant differences in root length and diameter in the first season only.

Beet plants of Athos poly variety was significantly increased in root length in the first season only. It produced longer roots than others varieties. While, Monte Bianco variety gave a large diameter in the same season.

No significant differences in root length and diameter were as evidenced among splitting potassium applications in 2005/2006 and 2006/2007 seasons.

2. Root and top yield:

Data in Table (2) show the effect of planting method, varieties and potassium fertilizer on root and top yield per feddan in 2005/2006 and 2006/2007 seasons.

There were significant differences in root and top yield was shown due to planting method in both seasons. Mechanical planting resulted a substantial increase in root yield (ton/fed.) compared with manual planting method in both seasons. The increase in root yield per feddan by application of mechanical planter method may be due to the more even arrangement of beet plants in mechanical planting method. Abd El-Salam (2008) came to the same conclusion. In the second season only, mechanical method had a significant effect on top yield per feddan. The highest top yield was obtained from beet plants sown by planter.

Varieties gave significant differences in root and top yield per feddan, the highest increase of root yield was 28.933 ton/fed. with Monto Bianco variety in the first season only, while, the highest values 11.011 ton fed. and 13.417 ton/fed. of top yield were obtained from Ras Poly in the two seasons, respectively. This may be attributed to growth characters of variety.

There was no evidence for significant difference in root and top yield by potassium fertilizer in both seasons.

The interaction between planting method and potassium fertilizer rate had highly a significant effect on root yield per feddan in the first season Table (3). The planting method by planter and potassium application at 48% K_2O rate resulted the highest root yield per feddan compared with manual planting method under any potassium rates in the two seasons. The

lowest root yield obtained from manual method and potassium fertilizer at 48% K_2O rate. Root yield was significantly increased and positively affected by increasing K-rates up to 48% Kg K_2O/fed. These findings are in close agreement with the previous results obtained by Khalifa *et al.*, 1995. The interaction between planting method, varieties and K-rates had a significant effect on root yield per feddan in the first season, only Table (4).

Table (3): Root yield (ton/fed.) of sugar beet as affected by the interaction between planting method and potassium fertilizer rate in 2005/2006 and 2006/2007 seasons.

Planting method	Root yield (ton/fed.)		
	Potassium fertilizer rates		
	Zero	24% K_2O	48% K_2O
	2005/2006		
Manual	24.850 bc	26.542 ab	23.217 c
Planter	28.083 a	28.058 a	28.467 a
	2006/2007		
Manual	26.542 ab	25.492 b	26.658 ab
Planter	28.292 ab	28.133 ab	28.658 a

Means of each factor designed by the same letter are not significantly different at 5% level using Duncan's multiple range.

The highest root yield (ton/fed.) was obtained form beet plants of Monto-Bianco variety sown by planter at 24% K_2O application in the first season only.

Table (4): Root yield ton/fed. of sugar beet as affected by the interaction between planting method, varieties and potassium fertilizer rate in 2005/2006 season.

Planting method	Varieties	Root yield (ton/fed.)		
		Potassium fertilizer rate		
		Zero	24 % K_2O	48% K_2O
Manual	Ras poly	23.200 g	25.433 c-f	30.500 a-d
	Farida	27.533 a-f	27.530 a-f	27.300 a-f
	Mont Bianco	24.500 d-g	28.000 a-f	28.200 a-f
	Athos poly	23.300 g	25.200 c-g	25.250 c-g
Planter	Ras poly	23.230 g	27.067 b-f	30.567 a-d
	Farida	28.100 a-f	28.933 a-e	31.500 abc
	Mont Bianco	28.933 a-e	32.900 a	31.267 abc
	Athos poly	23.501 fg	26.833 b-f	26.900 b-f

Means of each factor designed by the same letter are not significantly different at 5% level using Duncan's multiple range.

3. Quality parameters:

Total soluble solids (TSS), sucrose percentage and purity % as affected by planting method, variety and potassium fertilizer application in 2005/2006 and 2006/2007 seasons are presented in Table 5.

Planting method had no a significantly effect on quality parameters in root juice at harvest in both seasons.

Data in Table 5 show effect of planting method and potassium fertilizer rate on beet quality characteristics (TSS%, sucrose %, and purity) of sugar beet varieties under study. It was detected that the greatest significant increase of TSS% and sucrose % were 22.1%, 23.8% and 18.6%, 19%, respectively resulted from Farida variety in the two seasons.

There is no significant different between all cultivars under study in respect of purity in the two seasons.

Applied of K-24 kg K_2O/fed. gave the highest value of sucrose percentage in the second seasons, only. Farida cultivar was proved to be the most appropriate to cultivate under local environment.

Table (5): Percentage of total soluble solids (TSS), sucrose, sugar yield (ton/fed.) and purity of sugar beet as affected by planting method, varieties and potassium fertilizer in 2005/2006 and 2006/2007 seasons.

Characters / Factors	TSS %		Sucrose %		Sugar yield		Purity	
	2005/06	2006/07	2005/06	2006/07	2005/06	2006/07	2005/06	2006/07
Planting method (P)	N.S	N.S	N.S	N.S	*	*	N.S	N.S
• Manual	20.8	21.7	17.6	17.8	4.273 b	4.452 b	84.8	83.4
• Planter	21.4	22.5	18.0	18.0	5.216 a	5.063 a	84.4	81.9
Varieties (V)	*	**	*	*	*	**	N.S	N.S
• Ras poly	20.2 b	21.0 b	17.1 b	16.9 b	4.374 b	4.765 b	84.9	82.6
• Farida	22.1 a	23.8 a	18.6 a	19.0 a	5.194 a	5.105 a	84.2	81.8
• Monto Bianco	21.3 ab	21.0 b	17.9 ab	17.7 b	5.200 a	4.809 b	84.5	84.4
• Athos poly	20.8 ab	22.5 ab	17.6 ab	17.9 b	4.329 b	4.843 ab	84.8	81.9
Potassium rate (K)	N.S	N.S	N.S	*	N.S	*	N.S	N.S
• Control	20.5	21.9	17.4	17.2 b	4.671	4.705 b	84.8	81.5
• 24% K_2O	21.2	22.8	17.9	18.3 a	4.873	4.917 ab	84.5	82.3
• 48 % K_2O	21.6	21.6	18.2	18.3 a	4.716	5.020 a	84.4	84.3
Interaction								
P x V	*	N.S	*	*	*	**	*	*
P x K	*	N.S	*	N.S	*	N.S	N.S	N.S
V x K	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
P x K	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

*, ** and N.S. indicate $P < 0.05$, $P < 0.01$ and not significant, respectively.
Means of each factor designed by the same letter are not significantly different at 5% level using Duncan's multiple range.

4. **Sugar yield:**

Data in Table (5) show the effect of planting method, varieties and potassium fertilizer on sugar yield per feddan in 2005/2006 and 2006/2007 season.

There was a significant difference in sugar yield per feddan obtained between the two planting methods in favour of planting by mechanical planter. This may be due to the considerable increase in root yield and extractable white sugar %.

There was a substantial difference in sugar yield per feddan obtained among planting methods in both seasons. Beet plants sown mechanically out yielded those sown manually in sugar yield (ton/fed.) in the two seasons.

A significant differences among varieties under study in sugar yield were recognized in both seasons. Monte Bianco cultivar significantly increased sugar yield per feddan compared with other cultivars. This may be attributed to increasing extractable white sugar %.

Potassium application at 48 kg K_2O significantly increased sugar yield (ton/fed.) 5.020 ton/fed. compared with other rates of K in the second seasons, only. This may be due to increase in root yield (ton/fed.) and sucrose %.

The interaction between planting methods and all treated cultivars had a significant effect on sucrose percentage and sugar yield ton/fed. in 2005/2006 season Table (6 and 7). The highest sucrose % and sugar yield ton/fed. were obtained from beet of Monto Bianco cultivar by mechanical planting, while the lowest sucrose % and sugar yield ton/fed. were obtained from Monto Bianco cultivar and Athos poly cultivar, respectively. Farida cultivar gave the highest value of sucrose % (20.1%) by traditional method, while the lowest one (16.7%) obtained from Monto Bianco cultivar by manual planting in the second season, only.

The effect of combination between planting methods and K-fertilizer rates on sucrose % and sugar yield (ton/fed.) in the first season, only were presented in Table (8).

Table (6): Percentage of sucrose in root juice of sugar beet as affected by the interaction between planting method and variety under study.

Planting methods	Sucrose percentage			
	Varieties			
	Ras Poly	Farida	Monto Bianco	Athos Poly
	2005/2006 season			
Manual	16.9 cd	19.0 ab	16.7 d	17.7 bcd
Planter	17.3 cd	18.2 abc	19.2 a	17.5 cd
	2006/2007 season			
Manual	16.9 cd	20.1 a	16.7 d	17.4 bcd
Planter	17.0 cd	18.0 bcd	18.6 ab	18.3 bc

Means of each factor designed by the same letter are not significantly different at 5% level using Duncan's multiple range.

Table (7): Sugar yield (ton/fed.) of sugar beet as affected by the interaction between planting method and some varieties in 2005/2006 season.

Planting methods	Sugar yield (ton/fed.)			
	Varieties			
	Ras Poly	Farida	Monto Bianco	Athos Poly
Manual	4.370 c	5.447 ab	4.476 bc	4.145 c
Planter	4.377 c	4.901 bc	5.959 a	4.354 c

Means of each factor designed by the same letter are not significantly different at 5% level using Duncan's multiple range.

Table (8): Sucrose percentage and sugar yield (ton/fed.) of sugar beet as affected by the interaction between planting method and potassium fertilizer rate in 2005/2006 season.

Planting method	Sucrose %			Sugar yield (ton/fed.)		
	Potassium rate					
	Zero	24% K_2O	48% K_2O	Zero	24% K_2O	48% K_2O
Manual	16.5 b	17.9 a	18.3 a	4.064 b	4.742 ab	5.090 a
Planter	18.2 a	17.8 a	18.1 a	4.735 ab	5.150 a	5.440 a

Means of each factor designed by the same letter are not significantly different at 5% level using Duncan's multiple range.

By traditional method, the largest value of sucrose % obtained from K-application at 48 kg K_2O/fed. rate, while the lowest value of sucrose % was from manual method without K-fertilizer in 2005/2006 season, only.

Sugar yield ton/fed. as affected by the interaction between planting methods and K-fertilizer presented in Table 8. With respect to sugar yield was significantly affected by increasing K-rates from 0 to 48% K_2O/fed. Under condition of planter method. This trend can be explained on the base that high concentration of Na^+ could replace K^+ for uptake by sugar beet (Khalifa *et al.,* 1995).

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الملخص العربي

استجابة بعض اصناف بنجر السكر لطرق الزراعة والسماد البوتاسى

علاء ابراهيم بدر

محطة بحوث سخا ــ قسم المعاملات الزراعية

معهد بحوث المحاصيل السكرية ــ مركز البحوث الزراعية

اجريت تجربتين حقليتين فى منطقة الحامول محافظة كفرالشيخ فى موسمى ٢٠٠٥/٢٠٠٦ ، ٢٠٠٦/٢٠٠٧ لدراسة احسن طريقة لطريقتين من الزراعة هما الزراعة التقليدية (يدويا) مع الزراعة الالية (ماكينة ايطالية الصنع) تحت تأثير ثلاث مستويات من السماد البوتاسى (صفر ، ٢٤% ، ٤٨% كجم بو٢أ/فدان) اضيف كل معدل على حدة

بعد شهرين من الخف ودفعه واحدة وتم استخدام بذور اصناف راسى بولى ، فريده ، مونت بيانكو ، اسوس بولى وهـى اصـناف عدديـة الاجنه للدراسة. وتمت الزراعة بتاريخ الخامس من اكتوبر لموسـمى الدراسة.

وقد بينت النتائج الاتى:

- الزراعة الالية اعطت زيادة معنوية فى محـصولى الجـذور والسكر للفدان فى كلا الموسمين.
- الصنف فريدا زاد معنويا عن صنف اسوس بولى فى محصول الجذور للفدان فى الموسم الاول فقط وزاد فى محصول السكر فى كلا الموسمين.
- الصنف مونت بيانكو وفريدا لم يختلفا معنويا فى محـصولى الجذور والسكر للفدان فى الموسم الاول فقط.
- الصنف راس بولى تفوق على الاصناف الثلاثة الاخرى فـى محصول العرش للفدان فى كلا الموسمين.
- الصنف فريدا اعطى اعلى نسبة سكروز فى الموسمين.
- زيادة معدل البوتاسيوم من صفر الى ٤٨ كجم بـو٢أ/فـدان اعطى زيادة معنوية فى نسبة السكروز وايضا اعطى زيـادة فى محصول السكر للفدان فى الموسم الثانى فقط.