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EFFECT OF SOWING DATE AND PLANT DENSITY ON YIELD AND QUALITY OF SUGAR BEET

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ABSTRACT

The present study was conducted on clay soil at Sakha Agricultural Research Station, Agricultural Research Center during 2003/2004 and 2004/2005 seasons. The aim of this investigation was to find out the optimum plant population density and the suitable time of sowing for sugar beet. A spilt-plot experimental design was used with in three replication. The main results could be summarized as follows :

The results indicated that early sowing in October 10 produced the highest significant root yield, top yield, sugar yield/fad, root size, sucrose content and total soluble solids as compared with late sowing in November 25, in both seasons.

Although, the yields of roots and sugar per faddan were not affected when plant population ranged from 26250 to 52500 plants per faddan, however, it decreased significantly when the plant population was recorded to 26250 and 29400 plants per faddan over the two seasons.

Increasing hills spacing from 16, 20, 24, 28 to 32 cm significantly increased root diameter TSS% and significantly decreased top yield per fad. and purity percentage in both seasons. The combined results clearly showed that sowing at 16 or 20 cm hills pacing recorded highest root and sugar yield per fad.

INTRODUCTION

Sugar beet (*Beta vulgaris* L.) is the second important sugar crop after sugar cane in the world and Egypt. It is a source of high energy purs food and is also considered as an important source of feed for livestock

Several studies pointed out that sowing date is one of the most important factor affecting root yield and its attributes as well as quality of sugar beet. In Egypt, sowing sugar beet usually takes place during Sep., Oct. and Nov. Srivastava and Singh (1981) in India, found that sowing sugar beet on 5th Oct. gave significantly higher root and sugar yields as well as root sugar content than sowing on 20th Oct. or 20th Nov. Hanna et al. (1988) and El-Kassaby and Leilah (1992) and Ahmed (2003), in Egypt, reported that sowing sugar beet during Oct. markedly increased root diameter, root length, rot weight, sugar content as well as root and sugar yields than sowing during Nov.

Number of plants per faddan playing an important role in determining the final yield sugar beet. Plant density was studied by many investigators, Obead (1980); Assey et al. (1992); El-Kassaby ad Leilah (1992); Mahmoud et al. (1999); Bassal et al. (2001); Hassanin (2001); Nassar (2001); Ahmed (2003) and el-Geddawy et al. (2006). They reported that increasing plant density significantly increased root length as well as root, top and sugar yields/fad. They also found that root diameter, sucrose % and purity % were significantly decreased with increasing plant density. However no significant effect was observed on other quality characters of sugar beet due to different plant densities.

The objectives of this study was to determine the optimum date of sowing and the optimum plant population to obtain high quantity and quality of sugar beet under Kafr El-Sheikh conditions.

MATERIALS AND METHODS

Two field experiments were carried out at Sakha Agricultural Research Station, Agricultural Research Center during 2003/2004 and 2004/2005 seasons. Chemical analysis of soil experimental site in Table 1.

Table 1. Chemical analysis of the soil experimental site (0-30 cm depth) at farm of Sakha research Station, Kafr El-sheikh in 2003/2004 and 2004/2005 seasons.

Seasons	PH 1 : 2.5	EC m mhas cm.	Organic matter %	Available			Anions q/L.			
				N ppm	P ppm	K ppm	HCo_3^-	el^-	So_4^{--}	Co_3^{--}
2003/2004	8.4	3.37	1.80	15.52	6.40	280.60	6.4	6.2	0.22	0.0
2004/2005	8.2	3.34	1.85	16.05	6.35	285.31	6.5	6.3	0.20	0.0

A split-plot design, with three replicates was used in both seasons. The main plots were assigned to the two sowing dates: October 10 and November 25 in 2003/2004 and 2004/2005 seasons. The sub-plots included the following five plant densities: 52500, 42000, 34600, 29400 and 26250 plants per faddan that resulted from spacings of 16, 20, 24, 28 and 32 cm, between hills within rows, respectively.

Each plot contained 4 rows, 7 m-long and was 50 cm in width. The plants were thinned to one plant per hill after 40 days from sowing at the above hill spacing. The variety of sugar beet used in this study namely: Rasspoly was obtained from the Delta company for sugar in Kafr El-Sheikh Governorate.

Nitrogen fertilizer at a rate of 90 kW/fad. in the form of urea 46% N was added in two equal portions, half amount directly after thinning and other half after one month later.

After about 200 days form sowing date, the plants were ready to harvest. The two middle rows in each plot were harvested to prevent border effect and the yields of roots, tops and sugar were recorded. A random sample of ten roots from each plot were taken for measuring yield characters (root length and diameter and root weight) and sugar content. Total soluble solids (T.S.S.) was determined with a hand refractmeter. Percentage of sucrose in the roots was determined polarmeterically according to method of Le Docte (1927) and the clear juice purity was determined according to the method of Silin and Silina (1977). Data were statistically analyzed according to Sendacor and Cochran (1980) and treatment means were compared by Duncan's multiple range test, (Duncan, 1955).

RESULTS AND DISCUSSION

A. Root dimension

A.1. Root length

Significant differences in root length were obtained due to sowing date. The longest roots (32.5 and 28.56) resulted from plants sown in October 10 and the shortest roots (31.01 and 26.61) were produced from that sown in November 25 in 2003/2004 and 2004/2005 seasons, (Table 2). On the other hand, differences in root length due to the change in hill spacing from 16 to 32 cm were not significant. These results were in accordance with those finding by Obead (1980), Basha (1984), Assey *et al*. (1992), El-Kassaby and Leilah (1992) and Mahmoud *et al*. (1999).

Table 2. Root length and root diameter of sugar beet as affected by sowing date and hill spacing of ridges in 2003/2004 and 2004/2005 seasons.

Treatment	Root length (cm.)		Root diameter (cm.)	
	2003/2004	2004/2005	2003/2004	2004/2005
Sowing date (A) :				
10 October	32.50 a	28.56 a	11.25 a	10.82 a
25 November	31.01 b	26.61 b	10.29 b	9.40 b
F-test	*	**	*	**
Hill spacing (B) :				
16 cm	31.76	28.88	8.77 c	8.66 c
20 cm	31.60	28.50	10.62 bc	10.20 b
24 cm	31.20	27.92	11.40 b	10.70 b
28 cm	31.55	27.89	12.50 a	11.32 a
32 cm	31.70	27.86	12.61 a	11.40 a
F-test	NS	NS	**	**
Interaction	NS	NS	Ns	NS

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

A.2. Root diameter :

Data in Table 2 showed that the root diameter was significantly affected by sowing date and hill spacing in both seasons. The root diameter increased significantly with increasing distance between hills within rows but it decreased with the delay in sowing date. These results were in agreement with those obtained by Mahmoud *et al*. (1999) and Bassal *et al*. (2001).

B. Top, root and sugar yields per faddan

B.1. Top yield (t./fad.)

To[yield/fad. significantly affected by sowing date and hill spacing in both seasons. Top yield per faddan was decreased significantly with the delay in sowing date. Increasing in hill spacing decreased top yield/fdad. in both seasons. (Table 3).

Table 3. Top yield (t./fad.) of sugar beet as affected by sowing date and hill spacing in 2003/2004 and 2004/2005 seasons.

Treatment	Top yield (t./fad.)	
	2003/2004	2004/2005
Sowing date (A) :		
10 October	13.32 a	11.48 a
25 November	12.59 b	10.52 b
F-test	*	*
Hill spacing (B):		
16 cm	14.46 a	11.37 a
20 cm	13.54 b	11.24 a
24 cm	12.47 d	10.75 b
28 cm	11.45 e	9.36 c
32 cm	10.76 e	8.54 d
F-test	*	**
Interaction	NS	NS

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

The 16 cm whine row spacing treatment produced the highest yield of tops per faddan. The higher plant density of narrow spacing may explain the higher yield of tops per faddan as reported by Hanna, *et al*. (1988), Hassanin (2001) and Nassar (2001).

B.2. Root yield (t/fad)

The results in Table 4 indicated that root yield in tons per faddan was significantly affected by planting date and hill spacing In both seasons, the highest root yields were obtained from sowing early in October 10. The average root yield of sugar beet was decreased from about 26.86 to 22.61 tons/fad (15.82%), in 2003/2004 and from about 22.40 to 16.21 tons/fad (27.63%), in 2004/2005 as the sowing date was delayed from 10 October to 25 November.

When sugar beet plants were spaced at 16, 20 or 24 cm apart in 50 cm, rows, root yields per faddan were not affected significantly. Increasing the distances between hills within rows up to 32 cm significantly decreased yield of roots per faddan in both seasons. These are in general agreement with those obtained by Obead (1980), Srivastava and Singh (1981), Hanna *et al*. (1988), El-Kassaby and Leilah (1992), Mahmoud *et al*. (1999) and Bassal *et al*. (2001).

B.3. Sugar yield (t/fad)

The obtained results showed that sugar yields per faddan significantly affected by hill spacing in both seasons. There was a tendency for sugar yield to decrease as the hill spacing within row increased. Similar results were reported by Ahmed (2003) and El-Geddawy *et al*. (2006). On the other hand, Gerny (1975) found that sugar yield decreased as plant density was decreased and total sugar yield per faddan is a function of root yield and sucrose percentage. In 2003/2004, 2004/2005 the combined analysis, of the root yield and sucrose percentage were found to be decrease significantly with the delay in sowing from 16 October to 25 November.

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Consequently, the highest total sugar yields were obtained when sowing date was carried out in October 10 in both seasons, (Table 4). Moreover, root yield and sugar yield/fad were significantly higher in the first season than in the second season. Similar results were obtained by Ahmed (2003) and El-Geddawy *et al*. (2006).

C. Quality characters

C.1. Total soluble solids (T.S.S.)

The results in Table 5, the results clearly showed that the total soluble solids of sugar beet roots were decreased significantly with the delay in sowing dates during the two seasons from 10 October to 25 November). However, total soluble solids were increased as hill spacing became wider in 2003/2004 and 2004/2005 from 16 cm to 32 cm. Similar results were obtained by El-Kassaby and Leilah (1992); Mahmoud, *et al*. (1999); Hassanin (2001) and El-Geddawy *et al*. (2006).

C.2. Sucrose percentage

Statistical analyses showed that the percentage of sucrose was significantly affected by different spacing and sowing date for the two seasons of 2003/2004 and 2004/2005. The highest sucrose percentage was obtained from plants spaced at 24 cm apart within rows, but there were no significant differences among hills spacing of 24, 28 and 32 cm. (Table 5). Sugar beet plants sown in October 10 gave the higher sucrose percentage than in November 25. These results were in accordance with those of Assey *et al*. (1992) and Ahmed (2003) who found that sucrose percentage was increased as the within row spacing increased.

Table 5. Total soluble solids (T.S.S.), sucrose percentage and purity percentage of sugar beet as affected by sowing date and hill spacing of ridges in 2003/2004 and 2004/2005 seasons.

Treatment	T.S.S. %		Sucrose %		Purity %	
	2003/2004	2004/2005	2003/2004	2004/2005	2003/2004	2004/2005
Sowing date (A) :						
10 October	18.60 a	19.00 a	14.02 a	14.61 a	75.38	76.89
25 November	17.70 b	17.90 b	13.38 b	13.65 b	75.59	76.26
F-test	*	**	**	**	NS	NS
Hill spacing (B):						
16 cm	17.80 c	17.40 c	13.81 b	13.36 c	77.58 a	76.78
20 cm	17.90 c	18.90 b	14.10 a	14.38 b	78.77 a	77.73
24 cm	18.20 b	19.10 b	14.05 a	14.75 a	77.20 b	77.23
28 cm	18.30 b	19.20 ab	13.80 b	14.65 a	75.41 c	76.30
32 cm	20.00 a	19.60 a	13.68 b	14.72 a	68.40 d	75.10
F-test	*	*	*	**	*	NS
Interaction	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

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

C.3. Juice purity percentage

The results in Tables showed that the mean percentage of juice purity was not significantly affected by sowing date in both seasons, but hill spacing affected this character. The higher percentage of juice purity was obtained in

plants spaced at 24 cm distance within row. The increase in purity percentage may largely be due to the increase in sucrose percentage. Similar results were obtained by Obead (1980) Nassar (2001) and El-Geddawy (2006). In general, the change in plant populations from 29400 to 52500 plants per faddan did not affect the yield of roots per faddan. However, lower plant population (26250 plants per faddan) decreased root yield significantly over the two seasons. Therefore, the highest plant population of 52500 would result in the highest competition among plants and this would reduce the size of roots and sucrose percentage. This small size of sugar beet roots is not suitable for maximum sugar beet percentage. In the other hand, there would be a risk in planting the lowest plant population of 26250 due to the expected plant losses caused by hoeing, diseases, insects… etc. The highest values for all characters in the two seasons were obtained from sowing October 10. From the above findings one can recommend plant population of 34600 to 42000 plants per faddan and the sowing date at the second week of October to obtain high quantity and quality sugar beet.

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تأثير ميعاد الزراعة والكثافة النباتية على محصول وجودة بنجر السكر

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أجريت هذه الدراسة بالمزرعة البحثية لمحطة بحوث سخا (مركز البحوث الزراعية) خلال موسمى 2003-2004 ، 2004-2005 لدراسة تأثير ميعاد الزراعة (10 أكتوبر، 25 نوفمبر) والكثافة النباتية (26.250، 29.400، 34.600، 42.000، 52.500 ألف نبات للفدان) على محصول وجودة بنجر السكر ويمكن تلخيص أهم النتائج فيما يلى :

- أعطت الزراعة المبكرة فى 10 أكتوبر أعلى معنوية وإنتاجية من محصول الجذور والعرش والسكر لكل فدان وكذا حجم الجذور والنسبة المئوية للسكروز والمواد الصلبة الكلية الذائبة مقارنة بالزراعة المتأخرة فى 25 نوفمبر فى كلا الموسمين.
- لم يتأثر محصول الجذور والسكر جوهرياً عندما تراوحت الكثافة النباتية بين 34.600، 52.500 ألف نبات للفدان. بينما حدث نقص معنوى عند الكثافة 26.250ألف نبات للفدان.

أدت الزيادة بين الجور من 16، 20، 24، 28 حتى 32سم الى زيادة معنوية فى صفات قطر الجزر ونسبة المواد الصلبة ونسبة السكروز بينما أنخفض معنوياً محصول العرش للفدان ودرجة النقاوة للعصير فى كلا الموسمين وكان للكثافة لنباتية 16، 20سم أعلى محصول للجذور والسكر للفدان كمتوسط للمحصول فى الموسمين.

توصى النتائج أن أفضل موعد لزراعة بنجر السكر هو النصف الأول من أكتوبر وأن تتراوح الكثافة النباتية ما بين 34.60، 42.00 نبات للفدان للحصول على أعلى محصول وجودة بنجر السكر أى مع الزراعة على مسافات بين الجور 24، 20سم وذلك تحت ظروف محافظة كفرالشيخ.

Table 4. Average values for root and sugar yields of sugar beet in ton per faddan as affected by sowing date and distances between hills within rows during 2003/2004 and 2004/2005 seasons.

Treatment	2003/2004 season				2004/2005 season				Combined means			
	Root yield (t./fad.)		Sugar yield (t./fad.)		Root yield (t./fad.)		Sugar yield (t./fad.)		Root yield (t./fad.)		Sugar yield (t./fad.)	
	10 Oct.	25 Nov.	10 Oct.	25 Nov.	10 Oct.	25 Nov.	10 Oct.	25 Nov.	10 Oct.	25 Nov.	10 Oct.	25 Nov.
Hill spacing (B):												
16 cm	29.70 a	24.05 a	4.02 a	3.39 a	26.55 a	22.40 a	3.67 a	2.89 a	26.13 a	23.23 a	3.85 a	3.14 a
20 cm	28.08 b	23.59 b	4.10 a	3.20 a	23.96 b	20.48 b	3.57 a	2.84 a	26.02 b	22.04 a	3.84 a	3.02 a
24 cm	29.16 b	24.82 a	4.18 a	3.41 a	22.51 bc	20.31 b	3.42 b	2.90 a	25.83 b	22.57 a	3.80 a	3.16 a
28 cm	25.29 c	21.46 c	3.65 b	2.82 b	21.47 c	17.85 c	3.30 b	2.48 b	23.38 c	19.66 b	3.48 b	2.65 b
32 cm	22.06 d	19.14 d	3.18 c	2.46 c	17.51 d	16.39 c	2.66 c	2.33 b	19.79 d	17.76 c	2.92 c	2.40 c
Mean	26.86	22.61	3.83	2.42	22.4	16.21	2.10	2.69	24.23	21.05	3.58	2.87

Differences between means taking the same letter are not significant at 5% level according to Duncan's Multiple range test.