J. Plant Production, Mansoura Univ., Vol. 3 (10): 2567 - 2580, 2012

EFFECT OF PLANTING SYSTEMS, PLANT DENSITY AND NITROGEN FERTILIZER LEVELS ON PRODUCTIVITY AND QUALITY OF SUGAR BEET

Sarhan, H. M. ; M. A. E. Abdou and H. M. Al-Sayed
Sugar Crops Res. Inst., Agric. Res. Center, Giza, Egypt.

ABSTRACT

Two field experiments were carried out at Kafr El-Hamam Research Station, Zagazig district, Sharkia Governorate, Agricultural Research Center, Egypt, during 2007/2008 and 2008/2009 seasons to study the effect of planting systems (manual sowing and mechanical transplanting), plant densities (46000, 35000 and 28000 plants/fed) and nitrogen fertilizer levels (40, 60 and 80 kg N/fed) on yield and its components as well as quality of sugar beet (*Beta vulgaris* L.) cv. Plino.

The obtained results could be summarized as follows:

1-Mechanical transplanting system of sugar beet significantly surpassed the traditional sowing method (manual) in all studied characters and resulted in the highest values in both seasons.

2-Sowing sugar beet plants with low density (28000 plants/fed) recorded the highest values of root length and diameter, root and top fresh weights and TSS % in both seasons. While, sowing sugar beet plants with high density (46000 plants/fed) resulted in the highest values of sucrose and apparent purity percentages in both seasons. However, the highest yields of root and sugar were achieved as a result of sowing sugar beet with intermediate density (35000 plants/fed) in both seasons.

3-Fertilizing sugar beet plants with 80 kg N/fed significantly increased yields and its components as well as TSS % and markedly recorded the highest values in both seasons. Nitrogen fertilizer at the level of 60 kg N/fed produced the highest values of sucrose and apparent juice purity percentages in both seasons.

From the obtained results in this study, it can be concluded that sowing sugar beet using mechanical transplanting system with intermediate density (35000 plants/fed) and mineral fertilizing with 80 kg N/fed could be recommended in order to maximize its productivity and quality under the environmental conditions of Sharkia Governorate, Egypt.

Keywords: Sugar beet, *Beta vulgaris* L, sowing methods, mechanical transplanting, plant densities, plant population, nitrogen fertilizer levels, yield, quality.

INTRODUCTION

Sugar beet (*Beta vulgaris* L.) is one of just two crops (the other being sugar cane) which constitute the only important sources of sucrose product with sweetening. The importance of sugar beet crop to agriculture is not only confined to sugar production, but also to its wide adaptability to grown in poor, saline, alkaline and calcareous soils. Thus, it can be economically grown in the newly reclaimed lands as that at the Northern parts of Egypt as it is one of the most tolerant crops to salinity, as well as, it makes the soil in good conditions for the benefit of the following cereal crop. Developing high yielding varieties and its high demand for agricultural practices and other production input is necessary. Thereby, planting systems, plant densities and nitrogen fertilizer levels are among factors that enhance sugar beet productivity and quality.

Producers must try to use optimum planting systems, which are considered to be one of the most important elements of sugar beet production. There are a few investigations with respect to the effect of planting systems on sugar beet productivity. In this concern, Zahoor *et al.* (2007) showed that planting methods significantly affected the root and foliage weights, root/top ratio, root and top yields/ha of sugar beet crop. El-Geddawy *et al.* (2008) found that sowing sugar beet mechanically attained additional increment in root yield over those under the traditional method (sowing manually). Sarauskis *et al.* (2010) showed that the best results in terms of root yield up to 79.1 t/ha were achieved by using the rotary harrow or rotovator as compared with sowing was conventional drilling. Attia *et al.* (2011) showed that mechanical sowing method of sugar beet significantly surpassed the traditional sowing method (manual) in all studied characters.

With respect to plant densities, several studies reported that densities are the important factor for controlling sugar beet productivity and quality. In this concern, Mahmoud *et al.* (1999) reported that 20 cm plant spacing significantly increased size and weight of the individual roots, root yield/fed and gross sugar yield/fed. Dense sowing (15 cm plant spacing) significantly favored for sucrose accumulation, improved juice purity and significantly increased top yield/fed as compared to 20 cm plant spacing. Ramadan (1999) found that sucrose content, purity and recoverable sugar percentages were linearly reduced with the reduction in plant density. Root and sugar yields/fed were maximized when beets were growing at 42000 plants/fed. Bassal *et al.* (2001) reported that each increase in hill spacing until 30 cm was associated with marked increases in length and diameter of roots, top and root fresh weights/plant as well as root/top ratio and purity percentage. While, top, root and sugar yields/fed were increased with increasing hill spacing until 20 cm. However, total soluble solids and sucrose percentages were decreased with increasing hill spacing from 10 to 20 or 30 cm. Nassar (2001) noitced that increasing plant densities from 35000 to 70000 plans/fed was accompanied with a reduction in root length, diameter and weight, while number of roots per unit area at harvest was increased. Sucrose content, purity and recoverable sugar percentages were linearly decreased with increasing plant density. Abo El-Wafa (2002) showed that increasing plant spacing from 20 to 30 cm between hills increased root length, diameter and weight as well as root yield, weight of leaves per plant, sucrose and juice purity percentages. Omar *et al.* (2002) revealed that spacing of 20 cm between hills produced the highest root and sugar yields/fed as compared to 30 cm space. Leilah *et al.* (2005) reported that plant population markedly affected all studied characters. The highest root and sugar yields/ha were obtained with sowing sugar beet on both sides of ridges,70 cm width and 25 cm between plants. El-Geddawy *et al.* (2006) found that sowing sugar beet at 46666 plants/fed significantly reduced root length and increased purity %, root and sugar yields/fed. Root diameter, sucrose % and top yield/fed were insignificantly affected by plant densities.

Nitrogen is an essential element for sugar beet growth and yield. It is generally needed in most sugar beet soils, especially in places where nitrogen responsive modern sugar beet varieties are grown, like other plants sugar beet, requires number of mineral nutrients for proper growth and development. Nitrogen is referred as balance wheel of sugar beet nutrition because of the fact that the efficiency of other nutrients is based on it, as well as sugar beet productivity. In this concern, Ibrahim (1998), Seaada (1998), Abdou (2000), El-Shahawy *et al.* (2001), Ramadan *et al.* (2003), Seadh (2004), Leilah *et al.* (2007), Shewate *et al.* (2008) , El-Sarag (2009), Zhang *et al.* (2009), Jahedi and Noroozi (2010) and Attia *et al.* (2011) concluded that increasing nitrogen fertilizer levels substantially improved root, top and sugar yields as well as its components, whereas quality parameters were decreased.

Therefore, this study aimed to study the effect of planting systems, plant densities and nitrogen fertilizer levels on yield and its attributes as well as quality of sugar beet cv. Plino under the environmental conditions of El-Sharkia Governorate, Egypt.

MATERIALS AND METHODS

The present investigation was carried out at Kafr El-Hamam Research Station, Zagazig district, Sharkia Governorate, Agricultural Research Center, Egypt, during 2007/2008 and 2008/2009 seasons to study the effect of planting systems, plant densities and nitrogen fertilizer levels on yield and its components as well as quality of sugar beet cv. Plino as a multigerm variety.

Each planting systems (manual sowing and mechanical transplanting) was performed in separate experiment. Manual sowing method was undertaken by workers in ridges 60 cm in width and spaced 15, 20 and 25 cm between hills (3-4 seeds/hill) on one side of ridges. Plants were thinned at the age of 30 days from sowing to obtain one plant/hill (46000, 35000 and 28000 plants/fed). However, mechanical transplanting systems were performed by takes place nursery trays (pipes paper) on top of the field with area of 30 m^2/fed. The tray paper is made of special paper disintegrates when placed in soil, and contains around 720 tube, tube height about 12 cm. The tray was pulled from both sides in order to accommodate pipes in tray and installed on both sides, and then packed tubes to depth of 10 cm with mixture of fine soil and peat moss 1:1 ratio with mixing soil with one of fungicides, then placed one seed in each tube and covered with little soil then irrigation, and other agricultural practices were conducted regularly until the age of seedlings for about a month. Preparation of permanent land and ridging were performed as that in manual sowing. Transplanting of seedlings was performed by using transplanting machine, where the worker separates pipes from tray and feds it to the machine. The machine in turn make a groove on one side of ridge, where pipes which contain one seedling were placed on groove vertically with distance 15, 20 and 25 cm between seedlings, then the machine covering the accumulated soil on seedling, then cold irrigation was performed after the completion transplanting.

Each experiment of planting systems was performed in split plot design with four replicates in both seasons.

The main plots were occupied at random with three plant densities (46666, 35000 and 28000 plants/fed).

The sub-plots were devoted at random with three nitrogen fertilizer levels (40, 60 and 80 kg N/fed). Nitrogen was in form of ammonium nitrate (33.5%) was applied in two equal doses, the first was applied after thinning sugar beet plants (30 days after sowing) and the second portion was carried out before the third irrigation.

Each experimental basic unit (sub-plot) included 5 ridges, each 60 cm apart and 3.5 m length, which resulted an area of $10.5m^2$ (1/400 fad).The preceding summer crop was maize (*Zea mays* L.) in both seasons.

Soil samples were taken at random from the experimental field area at a depth of 0-30 cm from soil surface and prepared for both mechanical and chemical analysis, according to Jackson (1973).The results are presented in Table 1.

Table 1: Mechanical and chemical soil properties at the experimental site during the two growing seasons.

Mechanical and chemical analysis	Seasons	
	2007/2008	2008/2009
Sand %	12.0	13.9
Silt%	21.6	21.5
Clay %	62.1	61.0
Organic matter %	2.0	2.1
Avalable N(p.p.m)	52.5	51.4
Avalable P(p.p.m)	16.2	15.3
Avalable K(p.p.m)	37.40	36.5
$CaCO_3$%	1.3	2.6
pH	8.1	8.0

The experimental field well prepared by two ploughing, leveling, compaction, division and then divided to the experimental units. Calcium super phosphate (15.5 % P_2O_5) was applied during soil preparation at the rate of 150 kg/fed. Potassium sulphate (48 % K_2O) at the rate of 24 kg/fed was applied before the third irrigation.

Sugar beet balls were sown using dry sowing method as previously mentioned in the first week of November in both seasons. The plots were irrigated immediately after sowing directly. Weed control and nitrogen fertilization in beet fields were done as previously mentioned. Other cultural practices for growing sugar beet were performed as recommendations by Ministry of Agriculture and were followed, except the factors under study.

Studied characters:

A-Yield components:

At maturity (after approximately 195 days from sowing) five plants were chosen at random from the outer ridges of each sub-plot to determine yield attributes and quality characters as follows:

1. Root fresh weight (g/plant).
2. Foliage fresh weight (g/plant).
3. Root length (cm).
4. Root diameter (cm).

B- Yield quality:

1. Total soluble solids (TSS %) in roots. It was measured in juice of fresh roots by using Hand Refractometer.
2. Sucrose percentage (%). It was determined Polarimetrically on lead acetate extract of fresh macerated roots according to the method of Carruthers and OldField (1960).
3. Apparent purity percentage (%). It was determined as a ratio between sucrose % and TSS % of roots.

C-Yields:

At harvest, plants that produced from the two inner ridges of each sub-plot were uprooted and cleaned. Roots and tops were separated and weighted in kilograms, then converted to estimate:

1. Root yield (t/fad).
2. Sugar yield (t/fad). It was calculated by multiplying root yield by sucrose percentage.

All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for split plot design of each experiment (planting systems), then the combined analysis was carried out as outlined by Gomez and Gomez (1984) by using means of "MSTAT-C" computer software package. Least Significant Difference test (LSD) method was and test the differences between treatment means at 5% level of probability was reported as described by Waller and Duncan (1969).

RESULTS AND DISCUSSION

Planting systems effect:

From obtained results in Table 2, all yield components (root length and diameter, root and top fresh weights) had a significant effect owing to different planting systems studied in this experiment *i.e.* mechanical transplanting and manual sowing in the two growing seasons, except root diameter in the first season only. It can be also statement that mechanical transplanting system recorded the highest values of root length and diameter, root and top fresh weights in both seasons. In the other side, the lowest values of yield attributes of sugar beet were resulted from manual sowing method in both growing seasons.

Table 2: Root length and diameter, root and top fresh weights as affected by planting systems, plant densities and nitrogen fertilizer levels as well as their interaction during 2007/2008 and 2008/2009 seasons.

Characters / Treatments	Root length (cm)		Root diameter (cm)		Root fresh weight (g)		Top fresh weight (g)	
	2007/ 2008	2008/ 2009	2007/ 2008	2008/ 2009	2007/ 2008	2008/ 2009	2007/ 2008	2008/ 2009
A- Planting systems:								
Mechanical	19.31	20.40	13.96	14.66	627.7	624.3	281.9	275.5
Manual	18.17	19.04	13.92	13.98	592.4	612.0	265.3	273.5
F. test	*	*	NS	*	*	*	*	*
B- Plant densities:								
46000 plants/fed	18.67	19.31	10.05	10.16	378.1	384.8	168.9	171.8
35000 plants/fed	18.62	19.66	14.08	14.57	680.8	691.6	305.4	302.6
28000 plants/fed	18.93	20.19	17.69	18.23	771.2	778.1	346.6	349.2
F. test	*	*	*	*	*	*	*	*
LSD at 5 %	0.24	0.18	0.32	0.31	5.5	4.8	0.6	0.8
C- Nitrogen fertilizer levels:								
40 kg N/fed	16.70	17.68	12.97	13.75	457.7	451.3	205.9	201.8
60 kg N/fed	19.05	19.92	14.05	14.38	648.1	666.0	291.2	298.0
80 kg N/fed	20.48	21.55	14.80	14.84	724.3	737.1	323.9	323.8
F. test	*	*	*	*	*	*	*	*
LSD at 5 %	0.16	0.13	0.22	0.28	4.5	3.0	0.5	0.5
D- Interactions:								
A X B	*	*	NS	*	*	*	*	*
A X C	*	*	*	NS	*	*	*	*
B X C	*	*	*	*	*	*	*	*
A X B X C	*	*	NS	NS	*	*	*	*

Planting systems showed significant effect on quality parameters *i.e.* TSS, sucrose and purity percentages in the two seasons (Table 3). The highest values of these parameters were associated with mechanical transplanting system as compared with manual sowing system in both seasons. These results clear that mechanical transplanting system increased percentage of sucrose as compared with the two other one due to the decrease in root weight and root diameter, which leads to decreasing tissue water content and non-sucrose substance such as proteins and alpha amino nitrogen, which consequently increased sucrose % content in roots.

Root and sugar yields/fed significantly affected by planting systems, this comment was mostly true in the two seasons of study (Table 4). The optimum planting system that yielded the highest values of root and sugar yields/fed was mechanical transplanting system in both seasons. The corresponding data were 17.356 and 17.261 ton roots/fed, 3.211 and 3.394 ton sugar/fed in the first and second seasons, respectively. On the other hand, the lowest values of these traits were recorded under manual sowing system conditions in the two growing seasons.

Table 3: Total soluble solids (TSS), sucrose and apparent purity percentages as affected by planting systems, plant densities and nitrogen fertilizer levels as well as their interaction during 2007/2008 and 2008/2009 seasons.

Characters / Treatments	TSS (%)		Sucrose (%)		Apparent purity (%)	
	2007/2008	2008/2009	2007/2008	2008/2009	2007/2008	2008/2009
A- Planting systems:						
Mechanical	22.26	23.72	18.53	19.68	84.64	85.77
Manual	21.93	22.97	17.12	17.09	76.98	72.24
F. test	*	*	*	*	*	*
B- Plant densities:						
46000 plants/fed	21.65	22.87	18.31	18.88	84.59	82.45
35000 plants/fed	22.07	23.11	18.12	18.82	82.18	81.76
28000 plants/fed	22.56	24.06	17.05	17.45	75.67	72.80
F. test	*	*	*	*	*	*
LSD at 5 %	0.15	0.18	0.05	0.18	0.64	1.46
C- Nitrogen fertilizer levels:						
40 kg N/fed	21.75	22.92	17.96	18.52	81.66	79.69
60 kg N/fed	22.13	23.36	18.05	18.57	82.63	80.87
80 kg N/fed	22.40	23.75	17.47	18.06	78.14	76.45
F. test	*	*	*	*	*	*
LSD at 5 %	0.14	0.13	0.07	0.12	0.73	0.83
D- Interactions:						
A X B	*	NS	*	*	*	*
A X C	NS	*	*	NS	*	*
B X C	*	*	*	*	*	NS
A X B X C	*	NS	*	*	NS	*

Table 4: Root and sugar yields/fed as affected by planting systems, plant densities and nitrogen fertilizer levels as well as their interaction during 2007/2008 and 2008/2009 seasons.

Characters / Treatments	Root yield (t/fed)		Sugar yield (t/fed)	
	2007/2008	2008/2009	2007/2008	2008/2009
A- Planting systems:				
Mechanical	17.356	17.261	3.211	3.394
Manual	16.148	16.710	2.757	2.849
F. test	*	*	*	*
B- Plant densities:				
46000 plants/fed	13.917	14.162	2.557	2.680
35000 plants/fed	19.065	19.365	3.455	3.650
28000 plants/fed	17.276	17.430	2.940	3.035
F. test	*	*	*	*
LSD at 5 %	0.127	0.167	0.026	0.047
C- Nitrogen fertilizer levels:				
40 kg N/fed	12.664	12.540	2.276	2.322
60 kg N/fed	17.658	18.124	3.190	3.372
80 kg N/fed	19.935	20.293	3.486	3.671
F. test	*	*	*	*
LSD at 5 %	0.121	0.088	0.022	0.025
D- Interactions:				
A X B	*	*	*	*
A X C	*	*	*	*
B X C	*	*	*	*
A X B X C	*	*	*	*

These results may be attributed to the regularity spacing and numbers of plants between hills in mechanical transplanting system, which minimizing the intra competition between plants and led to high light use efficiency of solar radiation utilized by beet plants, in turn high in the conversion of light energy to chemical energy and consequently high accumulation of dry matter and improvement of yields and its components. Moreover, mechanical transplanting system can save time, effort and money as well as two irrigations as compared with manual sowing. In Addition, mechanical transplanting system is easier to weed control for possibility of giving false irrigation. These findings are in harmony with those reported by Zahoor *et al.* (2007), El- Geddawy *et al.* (2008) and Attia *et al.* (2011).

Plant density effect:

Root length and diameter, root and top fresh weights were significantly affected by plant densities in both growing seasons as shown in Table 2. The highest values could be obtained for all yield components were achieved when sowing sugar beet plants with density of 28000 plants/fed (low density) in both seasons. On the other hand, the minimum values for whole these characters were resulted from sowing sugar beet with density of 46000 plants/fed (high density) in both seasons. Noteworthy, the vegetative growth of sugar beet is vigorous in the low density more than the high density and this led to the increases in yield attributes.

Plant densities of sugar beet caused a significant effect on TSS %, sucrose % and apparent purity % in the first and second seasons (Table 3). The highest percentages of TSS were achieved as a result of sowing sugar beet with density of 28000 plants/fed (low density) in the first and second seasons. On the other side, the lowest percentages of TSS were resulted from sowing sugar beet with density of 46000 plants/fed (high density), whereas sowing sugar beet with density of 35000 plants/fed (intermediate density) came in the second rank in both seasons. With respect to sucrose and apparent purity percentages, the highest averages were obtained due to high density (46000 plants/fed), followed by intermediate density (35000 plants/fed) and lastly low density (28000 plants/fed) in the first and second seasons.

Root and sugar yields/fed were significantly responded due to plant densities of sugar beet in both seasons (Table 4). Noteworthy, sowing sugar beet with density of 35000 plants/fed (intermediate density) yielded the highest values of root and sugar yields/fed. Concerning sowing sugar beet with density of 28000 plants/fed (low density), its ranked after intermediate density with respecting their effect on root and sugar yields/fed in both seasons. On the other hand, high density (46000 plants/fed) resulted in the lowest means of yield characters in both seasons. Such enhancement in sugar beet yields due to sowing sugar beet with intermediate density (35000 plants/fed) may be due to the increments in number of plants per unit area at harvest over than low density (28000 plants/fed) and the increase in all yield attributes over than high density (46000 plants/fed), consequently improvement beet productivity. In this connection Ramadan (1999), Bassal *et* *al.* (2001), Nassar (2001), Omar *et al.* (2002) and Leilah *et al.* (2005) reported similar results.

Nitrogen fertilizer levels effect:

From obtained results in Tables 2 and 4, nitrogen fertilizer levels significantly affected yield components (root length and diameter, root and top fresh weights) as well as root and sugar yields/fed in both seasons. It can be easily consider that raising nitrogen levels markedly accompanied with obvious increase in all studied characters in both seasons. Application of 80 kg N/fed significantly resulted in the highest values of all studied characters in the two growing seasons. In addition, application of 60 kg N/fed produced the best results after aforementioned level in both seasons. However, the lowest values of all studied characters were resulted from application of 40 kg N/fed in the two seasons. The increment of sugar beet yields and its components gained by increasing nitrogen levels may be due to the role of nitrogen in developing root dimensions by increasing division or elongation of cells and also enhancing leaf initiation and increment of chlorophyll concentration in leaves and photosynthesis process. The aforementioned results generally are in good agreement with those stated by Seadh (2004), Shewate *et al.* (2008), El-Sarag (2009) and Zhang *et al.* (2009).

All yield quality determinations of sugar beet *i.e.* TSS (%), sucrose (%) and apparent juice purity (%) were significantly affected due to nitrogen fertilizer levels in both seasons (Table 3). The highest values of TSS % were resulted from the highest nitrogen fertilizer level (80 kg N/fed), while the lowest ones were produced from the lowest nitrogen fertilizer level (40 kg N/fed) in both seasons. Nitrogen fertilizer at the level of 60 kg N/fed produced the highest sucrose and apparent juice purity percentages. While, the further increment rate (80 kg N/fed) reduced quality determinations of sugar beet juice *i.e.* sucrose and apparent juice purity percentages in both season. These results may be due to the decrease in root weight and root diameter which led to decreasing tissue water content and non-sucrose substance such as proteins and alpha amino nitrogen, which consequently increased sucrose% content in roots, also increased purity%. Similar results were obtained by El-Geddawy *et al.* (2006), Seadh (2008) and El-Sarag (2009).

Regarding the effect of interactions, there are many significant effect of the interactions among studied factors on studied characters. We reported enough the significant interactions on root and sugar yields only.

A significant effects on root and sugar yields/fed in both seasons resulted from the interaction between planting systems and plant densities are presented in Table 5. Root and sugar yields/fed reached its maximum values with combination between mechanical transplanting system of sugar beet seedlings with density of 35000 plants/fed (intermediate density) in both seasons. It was followed by manual sowing of sugar beet seeds with density of 35000 plants/fed in the two growing seasons.

Effect of the interaction between planting systems and nitrogen fertilizer levels on root and sugar yields/fed was significant in both seasons, as shown in Table 6. Maximum means of root and sugar yields/fed were produced from mechanical transplanting system of sugar beet seedlings and fertilizing with 80 kg N/fed. On the other hand, minimum ones were induced from manual sowing of sugar beet seeds and mineral fertilizing with 40 kg N/fed in the first and second seasons.

Table 5: Root and sugar yields/fed as affected by the interaction between planting systems and plant densities during 2007/2008 and 2008/2009 seasons.

Characters		Root yield (t/fed)		Sugar yield (t/fed)	
Treatments	Seasons	2007/2008	2008/2009	2007/2008	2008/2009
Mechanical	46000 plants/fed	15.100	15.064	2.906	3.070
	35000 plants/fed	19.892	19.664	3.761	3.988
	28000 plants/fed	17.076	17.055	2.966	3.124
Manual	46000 plants/fed	12.733	13.260	2.208	2.289
	35000 plants/fed	18.237	19.066	3.149	3.311
	28000 plants/fed	17.475	17.804	2.914	2.946
F-test		*	*	*	*
LSD at 5%		0.180	0.236	0.037	0.066

Table 6: Root and sugar yields/fed as affected by the interaction between planting systems and nitrogen fertilizer levels during 2007/2008 and 2008/2009 seasons.

Characters		Root yield (t/fed)		Sugar yield (t/fed)	
Treatments	Seasons	2007/2008	2008/2009	2007/2008	2008/2009
Mechanical	40 kg N/fed	12.810	12.114	2.383	2.402
	60 kg N/fed	18.497	18.838	3.491	3.747
	80 kg N/fed	20.763	20.831	3.759	4.034
Manual	40 kg N/fed	12.518	12.965	2.168	2.243
	60 kg N/fed	16.819	17.409	2.889	2.997
	80 kg N/fed	19.108	19.755	3.213	3.307
F-test		*	*	*	*
LSD at 5%		0.171	0.124	0.032	0.036

Data presented in Table 7 indicate that the interaction between plant densities and nitrogen fertilizer levels had a significant effect on root and sugar yields/fed during the first and second seasons. Root and sugar yields/fed was significantly increased with every increase in nitrogen fertilizer under studied plant densities. Moreover, the highest means of root yield were produced from sowing sugar beet with density of 35000 plants/fed (intermediate density) and fertilizing with 80 kg N/fed in both seasons. On the other wise, the lowest ones resulted from sowing sugar beet with density of 46000 plants/fed and fertilizing with 40 kg N/fed in the first and second seasons.

The highest averages of root and sugar yields/fed were obtained under mechanical transplanting system of sugar beet seedlings with density of 35000 plants/fed (intermediate density) along with fertilizing by 80 kg N/fed, while the lowest ones were obtained with manual sowing + high density + 40 kg N/fed in both seasons (Table 8).

From the obtained data in this study, it can be concluded that sowing sugar beet using mechanical transplanting system with intermediate density (35000 plants/fed) and mineral fertilizing with 80 kg N/fed in order to maximizing its productivity and quality under the environmental conditions of Sharkia Governorate, Egypt.

Table 7: Root and sugar yields/fed as affected by the interaction between plant densities and nitrogen fertilizer levels during 2007/2008 and 2008/2009 seasons.

Characters		Root yield (t/fed)		Sugar yield (t/fed)	
Treatments	Seasons	2007/2008	2008/2009	2007/2008	2008/2009
46000 plants/fed	40 kg N/fed	11.316	11.380	2.082	2.112
	60 kg N/fed	13.866	14.239	2.595	2.727
	80 kg N/fed	16.568	16.867	2.995	3.170
35000 plants/fed	40 kg N/fed	14.011	14.197	2.556	2.712
	60 kg N/fed	19.954	20.188	3.683	3.875
	80 kg N/fed	23.229	23.710	4.125	4.362
28000 plants/fed	40 kg N/fed	12.665	12.042	2.188	2.142
	60 kg N/fed	19.154	19.944	3.293	3.514
	80 kg N/fed	20.009	20.302	3.338	3.480
F-test		*	*	*	*
LSD at 5%		0.210	0.152	0.039	0.043

Table 8: Root and sugar yields/fed as affected by the interaction among planting systems, plant densities and nitrogen fertilizer levels during 2007/2008 and 2008/2009 seasons.

Characters		Root yield (t/fed)					
Seasons		2007/ 2008			2008/ 2009		
Treatments		40 kg N/fed	60 kg N/fed	80 kg N/fed	40 kg N/fed	60 kg N/fed	80 kg N/fed
Mech-anical	46000 plants/fed	11.764	16.008	17.529	11.170	16.164	17.859
	35000 plants/fed	14.233	20.673	24.771	14.115	20.343	24.536
	28000 plants/fed	12.432	18.809	19.988	11.059	20.007	20.099
Manual	46000 plants/fed	10.868	11.724	15.607	11.590	12.314	15.876
	35000 plants/fed	13.789	19.235	21.687	14.280	20.034	22.884
	28000 plants/fed	12.898	19.499	20.030	13.026	19.881	20.506
F-test		*			*		
LSD at 5%		0.297			0.215		
Characters		Sugar yield (t/fed)					
Mech-anical	46000 plants/fed	2.251	3.138	3.330	2.256	3.324	3.631
	35000 plants/fed	2.709	4.031	4.541	2.921	4.210	4.834
	28000 plants/fed	2.188	3.304	3.405	2.027	3.708	3.638
Manual	46000 plants/fed	1.913	2.051	2.659	2.028	2.130	2.710
	35000 plants/fed	2.404	3.334	3.708	2.504	3.539	3.890
	28000 plants/fed	2.188	3.282	3.271	2.197	3.320	3.322
F-test		*			*		
LSD at 5%		0.055			0.062		

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تأثير نظم الزراعة والكثافة النباتية ومستويات السماد النيتروجينى علـــى إنتاجيـــة وجودة بنجر السكر

حازم محمود سرحان، محمد على الدسوقى عبده و حسين محمد السيد
معهد بحوث المحاصيل السكرية – مركز البحوث الزراعية – الجيزة – مصر.

أجريت تجربتان حقليتان بمحطة البحوث الزراعية بكفر الحمام – مركـــز الزقـــازيق – محافظة الشرقية خلال موسمى ٢٠٠٧ /٢٠٠٨ و٢٠٠٨/٢٠٠٩ بهدف دراسة تأثير نظم الزراعـــة (الزراعة الألية للشتلات والزراعة اليدويـــة) والكثافـــة النباتيـــة (٤٦٠٠٠ ، ٣٥٠٠٠ و ٢٨٠٠٠ نبات/فدان) ومستويات السماد النيتروجينى (٤٠ ، ٦٠ و٨٠ كجم نيتروجين/فدان) علـــى صـــفات الجودة والمحصول فى بنجر السكر صنف بلينو.

ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى:

١- أظهرت الزراعة الألية لشتلات بنجر السكر تفوقا معنويا على الزراعة اليدوية للبـــذور فـــى جميع الصفات تحت الدراسة حيث أنتجت أعلى القيم لتلك الصفات فى كلا موسمى الدراسة.

٢- أدت زراعة بنجر السكر بالكثافة النباتية المنخفضة (٢٨٠٠٠ نبات/فدان) للحصول على أعلى القيم لصفات طول وقطر الجذر ، الوزن الغض للجذر والعرش ، النسبة المئوية للمواد الكلية الصلبة الذائبة (TSS%) فى كلا الموسمين. بينما أظهرت زراعة بنجر السكر بالكثافة العالية (٤٦٠٠٠ نبات/فدان) الحصول على أعلى القيم لصفات النسبة المئوية للسكروز والنقاوة فـــى كلا الموسمين. فى حين أن زراعة بنجر السكر بالكثافة المتوسطة (٣٥٠٠٠ نبات/فدان) أدت إلى الحصول على أعلى القيم لمحصول الجذور والسكر فى كلا موسمى الدراسة.

٣- نتجت أعلى القيم لصفات طول وقطر الجذر ، الوزن الغض للجذر والعرش ، النسبة المئوية للمواد الكلية الصلبة الذائبة (TSS%) ومحصول الجذور والسكر للفدان عند التسميد المعدنى لبنجر السكر بمعدل 80 كجم نيتروجين/فدان فى كلا موسمى الزراعة. بينمـــا أعلـــى القـــيم لصفتى النسبة المئوية للسكروز والنقاوة فقد تم الحصول عليها عند التسميد المعـــدنى لبنجـــر السكر بمعدل ٦٠ كجم نيتروجين/فدان فى كلا موسمى الدراسة.

عموماً يوصى بالزراعة الألية لشتلات بنجر السكر بالكثافة النباتية المتوســـطة (٣٥٠٠٠ نبات/فدان) بالإضافة إلى التسميد المعدنى بـــعدل ٨٠ كجم نيتروجين/فدان للحصول علـــى أعلـــى إنتاجية لمحصول بنجر السكر تحت ظروف محافظة الشرقية.

قام بتحكيم البحث

أ.د / محسن عبد العزيز بدوى	كلية الزراعة – جامعة المنصورة
أ.د / حمدى عبد الصادق باشا	كلية الزراعة – جامعة الزقازيق