Effect of Planting Dates, Plant Population and Nitrogen Fertilization on Sugar Beet Productivity Under the Newly Reclaimed Sandy Soils in Egypt

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Abstract:

This investigation was carried out in a newly reclaimed sandy soil to study the effect of planting dates, plant populations, nitrogen fertilizer levels and times of its application and their interactions on sugar beet productivity. Plant population markedly affected all studied characters in the two seasons**.** The highest root and sugar yields ha^{-1} were obtained with sowing sugar beet on both sides of ridges, 70 cm width and 25 cm between plants (114240 plants ha^{-1}). Nitrogen levels had significant effects on all estimated characters in both seasons. Adding 250 Kg N ha^{-1} produced the highest values of length, diameter and fresh weight of roots, foliage fresh weight as well as root, top and sugar yields ha^{-1}. Split application of nitrogen into four equal portions (45, 60, 75 and 90 days after planting) was associated with the highest values of length, diameter and fresh weight of roots, foliage fresh weight, purity percentage as well as root, top and sugar yields ha^{-1}. In general, it can be concluded that sowing sugar beets on first of October on both sides of ridges, 70 cm width and 25 cm apart (114240 plants ha^{-1}) and the addition of 250 Kg N ha^{-1} into four equal portions (45, 60, 75 and 90 days after planting) was the best treatment for maximizing sugar beet productivity in the newly reclaimed sandy soils under the environmental conditions of the present study.

Introduction

Sugar beet (*Beta vulgaris* L.) ranks the second important sugar crop after sugar cane, producing annually about 40 % of sugar production all over the world. Despite the newness of sugar beet in Egypt, it has a large importance where there are wide newly reclaimed sandy soils at the northern parts of Egypt, that could be cultivated with sugar beet without competition from other winter crops because of its tolerance to salinity and the ability to produce high yields of sugar under saline soil and water conditions, compared with most of other traditional winter crops.

Planting date has an active role on growth, yield and quality of sugar beet. Under the environmental conditions of Egypt, there is a general agreement that early planting of sugar beet (September-October) produced the highest sucrose percentage as well as root and sugar yields per unit area (Badawi *et al.,* 1995; Ghonema, 1998 and Ramadan and Hassanin, 1999). Other studies found that planting sugar beet during October markedly increased diameter, length and weight of roots, sugar content as well as root and sugar yields, compared with the late sowing of November (El-Kassaby and Leilah, 1992a; Leilah and Nasr, 1992 and Badawi *et al*., 1995).

The optimum plant population in sugar beet is very necessary to have high root yields with good quality. El-Khatib (1991) reported that increasing plant density from 35000 to 40000 and 46500 plants fad^{-1} (fad=0.42 ha) resulted in an increase in top, root and sugar yields, respectively. El-Kassaby and Leilah (1992b) stated that maximum diameter and weight of roots were obtained with planting beets on one side of ridges 70 cm width, 30 cm apart (20000 plants fad^{-1}). The highest yields of roots and sugar (ton fad^{-1}) were obtained with planting beets on both sides of ridges 70 cm width, 25 cm apart (48000 plants fad^{-1}). Sultan *et al*.,(1996) studied the effect of plant populations (35000, 46500, 52500 and 70000 plants fad^{-1}) on sugar beet in north delta region. They stated that the highest yields of roots and sugar were obtained with the plant population of 46500 plants fad^{-1} in both seasons. On the other hand, the lowest values of root and sugar yields were obtained with the density of 35000 plants fad^{-1}. Ramadan (1999) and Mahmoud *et al*., (1999) found that increasing the distance between hills from 15 to 20 cm significantly increased size and weight of individual roots, root yield fad^{-1}, gross sugar yield /fad and yield of recoverable sugar yield/fad^{-1}.

Nitrogen is the most important fertilizer element for sugar beet growth and yield (Badawi 1989a & b, Emara 1990 and El-Kassaby and Leilah 1992 b). Increasing nitrogen rate up to 70 Kg N fad^{-1} (Badawi 1996 and Salama and Badawi 1996), 75 Kg N fad^{-1} (Badawi *et al* 1995), 80 Kg N fad^{-1} (Mahmoud *et al.* 1990), 105 Kg N fad^{-1} (Neamet Alla 1997), 90 Kg N fad^{-1} (Basha 1999, El-Hawary 1999 and Mahmoud *et al* 1999, Mahasen, Fahmi 1999 and Shahr-Zad 1999) and 120 Kg N fad^{-1} (Sorour *et al* 1992, El-Hennawy *et al* 1998 and Sarhan 1998) significantly increased root length,

root diameter as well as root, top and sugar yields fad, but it resulted in marked reduction in TSS, juice purity and sucrose percentage.

Adding nitrogen in the suitable time has an effective role in maximizing the N utilization through minimizing losses of the applied nitrogen (Shahr-Zad 1999). El-Hennawy *et al*., (1998) concluded that split addition of nitrogen in two equal portions at 4 and 8 leaf stages increased root and recoverable sugar yields. Mahasen, Fahmi (1999) found that adding nitrogen into two equal portions 1/2 before the first irrigation (BFI) + 1/2 before the second irrigation (BSI) resulted in the highest means of fresh weight and root, top and sugar yields fad^{-1}.

The interaction between rate and time of N application had significant effects on sucrose percentage and sugar yield (Badawi 1989a; El-Hennawy *et al.* 1998 and Shahr-Zad 1999). The highest root diameter as well as root and sugar yields fad^{-1} were obtained with the addition of 90 Kg N fad^{-1} in two equal portions (1/2 before the first irrigation+1/2 before the second irrigation (Mahasen, Fahmi 1999).

Materials and Methods

This investigation was carried out in a newly reclaimed sandy soil at Kalabsho region in the northern district of Belkas, Dakahlia Governorate, Egypt, during the two successive seasons of 1994/95 and 1995/96. The purpose was to study the effect of planting dates, plant populations, nitrogen fertilization and their interactions on sugar beet productivity CV. Kawemira. This study included three planting dates (first of September, October and November). Each planting date was conducted in a separate experiment. A split-split plot design with four replicates was used for each planting date. The main plots were devoted to the following four plant populations:

- 71400 plants ha-1 (Planting on one side of ridges, 70 cm width and 20 cm apart).
- 142800 plants ha-1 (Planting on both sides of ridges, 70 cm width and 20 cm apart).
- 57120 plants ha^{-1} (Planting on one side of ridges, 70 cm width and 25 cm apart).

– 114240 plants ha^{-1} (Planting on both sides of ridges, 70 cm width and 25 cm apart).

The sub plots were occupied by the three nitrogen fertilizer levels, i.e. 150, 200 and 250 Kg N ha^{-1}. Meanwhile, the sub-sub plots were allocated with the following three split applications of nitrogen fertilizer:

– Two equal portions (at 45 and 60 days after planting).
– Three equal portions (at 45, 60 and 75 days after planting).
– Four equal portions (at 45, 60, 75 and 90 days after planting).

Nitrogen was added in the form of ammonium sulphate (20.5 % N) at the previously mentioned levels, times and dressings. Each experimental unit contained five ridges, 70 cm width and 6.0 m long, occupying an area of 21.0 m^2. Sugar beet was preceded by sunflower (*Helianthus annus* L.) in both seasons. Sowing of dry sugar beet balls took place in dry soil during the aforementioned dates to have four plant populations as previously mentioned. Irrigation was applied after sowing immediately. Beet plants were thinned to one plant $hill^{-1}$ at the age of 40 days from planting. All normal agricultural practices with the exception of the studied factors were carried out as usually done by farmers in the district. Plants were harvested when the outside leaves of these plants turned yellow.

At harvest, ten plants were taken at random from each plot to estimate root length (cm), root diameter (cm), root fresh weight (g $plant^{-1}$), foliage fresh weight (g $plant^{-1}$), root / top ratio, total soluble solids of roots (T.S.S), which was determined in fresh root by using hand refractometer. Sucrose (%) was estimated polarimetrically on a lead acetate extract of fresh macerated roots according to Le - Docte (1927). Juice purity (%) was calculated by dividing Sucrose (%) / T.S.S (%). Root and top yields (t ha^{-1}): Sugar beet plants in two ridges of each experimental unit (sub-sub plot) were harvested, cleaned and collected, thereafter roots and tops were separated and each was weighted in Kg, then after, it was converted to estimate root and top yields (ton ha^{-1}). Sugar yield (t ha^{-1}) calculated by multiplying root yield by sucrose percentage.

All data of each sowing date in each season were statistically analyzed according the technique of analysis of variance (AOV) of the split-split plot in randomized complete bock design. Then, the combined analysis for the

three studied sowing dates was done in each season according to the method stated by Gomez and Gomez (1984). Treatment means were compared using the least significant difference (LSD) method.

Results and Discussion:

1. Effect of planting dates: Data listed in Tables (1,2,3 and 4) show that planting dates had significant effects on all estimated characters in both seasons. Sowing sugar beets on 1st Oct. resulted in significant increases in length, diameter and fresh weight of roots, foliage fresh weight, root/top ratio as well as root, top and sugar yields ha^{-1}. Meanwhile, the highest TSS, sucrose and purity percentages were found with planting sugar beets on 1st Sept. The increase in root yield with first Oct. planting might be attributed to the good weather conditions that promoted phytosynthesis and improved growth of sugar beet and hence increase root yield. El-Kassaby and Leilah (1992); Leilah and Nasr (1992) and Badawi, *et al*. (1995) came to similar results reporting that October planting markedly increased diameter, length and weight of roots, sugar content as well as root and sugar yields, compared with the late sowing of November.

2. Effect of plant populations: Plant population significantly affected all studied characters in both seasons (Tables 1- 4). Plant population of 57120 plants ha^{-1} (sowing sugar beet on one side of ridges, 70 cm width and 25 cm between plants) produced the highest root diameter, root fresh weight, foliage fresh weight, root/top ratio, total soluble solids % and sucrose %. The highest root and sugar yields ha^{-1} were obtained with sowing sugar beet on both sides of ridges, 70 cm width and 25 cm between plants (114240 plants ha^{-1}), while planting 142800 plants ha^{-1}, i.e. sowing sugar beet on both sides of ridges, 70 cm width and 20 cm between plants recorded the maximum root length and top yield. The increase in root yield with sowing sugar beet on both sides of ridges, 25 cm apart (114240 plants ha^{-1}) might be due to the high leaf light interception, which contribute positively to higher photosynthesis with the relative increase in number of roots ha^{-1}. Sultan *et al* (1996), Mahmoud *et al* (1999) and Ramadan (1999) came to similar results.

3. Effect of nitrogen fertilizer levels: Data listed in Tables (1-4) reveal that nitrogen fertilizer levels had significant effects on all estimated characters in

both seasons. Adding 250 Kg N ha^{-1} was associated with the highest values of length, diameter and fresh weight of roots, foliage fresh weight as well as root, top and sugar yields ha^{-1}. The highest values of TSS, sucrose and purity percentages were obtained with the addition of 150 Kg N ha^{-1}. Purity percentage was markedly affected by nitrogen levels in the first season, while the difference in the second season did not reach the level of significant. The increase in root yield with the increase in nitrogen levels might be attributed to the role of nitrogen in enhancing growth, chlorophyll formation, photosynthesis process and hence increasing yield and its attributing variables. Similar observations were reported by Badawi (1996), Salama and Badawi (1996), Mahasen, Fahmi (1999) and Shahr-Zad (1999). On the other hand, the increase in nitrogen levels was associated with marked reduction in T.S.S., sucrose % and purity %. TSS decreased from 23.84 to 23.33 and 22.78% with the increase in N levels from 150 to 200 and 250 Kg N ha^{-1}. The decrease in TSS with the increase of N level might be due to the role of nitrogen in increasing moisture content in root tissues. Salama and Badawi (1996) and Mahasen, Fahmi (1999) came to similar results.

4. Effect of nitrogen application times: Data presented in Tables (1- 4) show the effect of split application of nitrogen on sugar beet yield, yield attributes and quality. In both seasons, split application of nitrogen fertilizer into four equal portions (at 45, 60, 75 and 90 days after planting) was associated with the highest values of length, diameter and fresh weight of roots, foliage fresh weight, purity percentage as well as root, top and sugar yields ha^{-1}. Adding nitrogen into two, three and four equal portions was associated with root yields of 39.476, 41.393 and 43.048 ton ha^{-1} and sugar yields of 7.131, 7.321and 7.476 ton ha^{-1}, respectively. On the other hand, the split addition of nitrogen fertilizer into two equal portions (at 45 and 60 days after planting) recorded the highest root / top ratio, T.S.S and sucrose percentage. The increase in root and sugar yields with the split application of nitrogen might be attributed to the increase in nitrogen use efficiency with the split application of nitrogen to four portions, which reduce N loss to relatively low limit particularly in the sand soils, besides the continuous supply of plants from nitrogen. Similar result were stated by Mahasen, Fahmi (1999) and Shahr-Zad (1999).

Table (1)

Averages of root length and diameter (cm) and fresh weights (g) as affected by planting dates, plant populations, N-levels and times of N application during 1994/95 and 1995/96 seasons.

Character	Root length (cm)								Root diameter (cm)								Root fresh weight (g)							
Season	1994/95				1995/96				1994/95				1995/96				1994/95				1995/96			
Planting date	D1	D2	D3	Comb	D1	D2	D3	Comb	D1	D2	D3	Comb	D1	D2	D3	Comb	D1	D2	D3	Comb	D1	D2	D3	Comb
A- Plant populations																								
71400 plants/ha	27.2	28.4	26.0	27.2	27.9	28.9	26.3	27.8	8.8	9.1	8.5	8.8	8.9	9.8	8.4	9.0	489.3	559.9	457.1	502.1	520.0	598.3	475.0	531.1
142800 plants/ha	29.8	30.9	28.5	29.8	30.5	31.6	28.9	30.3	7.4	8.0	7.2	7.5	7.6	8.1	7.2	7.6	306.1	361.8	280.4	316.1	312.8	377.4	295.3	328.5
57120 plants/ha	26.9	28.0	25.6	26.9	27.7	28.7	26.0	27.5	9.3	9.6	8.9	9.3	9.5	10.2	9.0	9.5	594.9	669.4	569.4	611.3	603.3	684.9	594.0	627.4
114240 plants/ha	29.1	30.2	28.0	29.1	29.5	31.1	28.0	29.6	8.1	8.5	7.7	8.1	8.4	8.9	8.2	8.5	390.5	459.4	372.1	404.8	413.8	487.1	387.2	429.4
F-test	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
LSD (5%)	0.2	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.3	0.2	0.3	0.1	0.3	0.4	0.5	0.2	4.3	5.9	8.5	3.4	10.6	10.5	12.4	5.9
B- N levels																								
150 kg N/ha	27.4	28.6	26.1	27.4	28.1	29.2	26.4	27.9	7.4	7.9	7.1	7.4	7.5	8.4	7.0	7.6	427.3	485.2	397.7	436.7	441.9	510.0	413.3	455.1
200 kg N/ha	28.6	29.6	27.5	28.6	29.2	30.3	27.6	29.0	8.4	8.8	8.0	8.4	8.7	9.3	8.3	8.7	445.3	510.0	422.0	459.1	461.4	538.1	440.4	480.0
250 kg N/ha	28.9	29.9	27.5	28.8	29.4	30.7	27.9	29.3	9.4	9.7	9.1	9.4	9.5	10.2	9.3	9.7	463.0	537.0	439.6	479.9	484.2	562.6	459.9	502.2
F-test	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
LSD (5%)	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.1	3.0	4.4	8.4	3.2	8.8	8.2	9.9	5.0
C- N application																								
2 equal portions	27.9	29.0	26.5	27.8	28.2	29.5	26.6	28.1	7.8	8.2	7.5	7.8	8.1	8.8	7.7	8.2	427.3	487.2	402.7	439.1	443.0	515.6	420.6	459.8
3 equal portions	28.2	29.3	27.0	28.2	28.9	30.0	27.3	28.8	8.5	8.8	8.1	8.5	8.6	9.3	8.3	8.7	445.2	511.7	424.4	459.4	463.8	537.4	440.9	480.7
4 equal portions	28.8	29.7	27.6	28.7	29.5	30.7	28.0	29.4	9.0	9.3	8.6	9.0	9.1	9.7	8.7	9.2	463.1	533.4	435.2	477.3	480.6	557.7	452.1	496.8
F-test	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
LSD (5%)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.2	0.2	0.2	0.1	3.0	3.7	7.3	2.9	6.8	7.6	6.8	0.4
Means	28.3	29.4	27.0	28.2	28.9	30.1	27.3	28.8	8.4	8.8	8.1	8.4	8.6	9.3	8.2	8.7	445.2	510.8	419.8	458.6	462.5	536.9	437.9	479.1
F-test		**				**				**				**				**				**		
LSD (5%)		0.2				0.3				0.1				0.3				2.9				5.1		

D1 = 1st Sept. , D2= 1st Oct. and D3= 1st Nov.

Table (2)

Averages of foliage fresh weights (g), root/top ratio and total soluble solids (TSS%) as affected by planting dates, plant populations, N-levels and times of N application during 1994/95 and 1995/96 seasons.

Character	Foliage fresh weight (g)								Root/top ratio								TSS %							
Season	1994/95				1995/96				1994/95				1995/96				1994/95				1995/96			
Planting date	D1	D2	D3	Comb	D1	D2	D3	Comb	D1	D2	D3	Comb	D1	D2	D3	Comb	D1	D2	D3	Comb	D1	D2	D3	Comb
A- Plant populations																								
71400 plants/ha	289.0	309.6	277.1	291.9	311.8	349.9	285.0	315.6	1.70	1.81	1.66	1.73	1.67	1.72	1.67	1.69	24.99	24.42	23.55	24.32	24.02	23.16	23.06	23.42
142800 plants/ha	197.5	209.7	197.8	201.7	227.8	257.4	221.7	235.6	1.56	1.73	1.43	1.57	1.38	1.47	1.35	1.40	22.76	21.51	21.56	21.94	21.63	21.16	21.00	21.26
57120 plants/ha	316.7	326.1	303.1	315.3	314.0	340.9	314.6	325.8	1.89	2.06	1.89	1.95	1.94	1.97	1.90	1.94	26.16	25.44	24.89	25.50	25.00	24.66	24.46	24.71
114240 plants/ha	242.2	258.9	227.4	242.8	259.3	283.2	253.2	265.2	1.62	1.76	1.65	1.68	1.61	1.73	1.54	1.63	23.33	22.91	22.35	22.86	22.67	22.59	22.29	22.52
F-test	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
LSD (5%)	9.0	10.1	11.4	5.4	7.7	14.0	8.5	4.5	0.08	0.07	0.08	0.04	0.05	0.09	0.06	0.04	0.14	0.40	0.26	0.13	0.32	0.25	0.41	0.17
B- N levels																								
150 kg N/ha	244.0	256.7	229.8	243.5	260.9	285.8	239.5	262.1	1.74	1.88	1.71	1.78	1.68	1.77	1.71	1.72	24.94	23.98	23.45	24.12	23.87	23.49	23.32	23.56
200 kg Nha	262.6	274.3	253.2	263.4	281.8	312.9	274.1	289.6	1.68	1.85	1.65	1.73	1.62	1.71	1.59	1.64	24.31	23.57	23.16	23.68	23.33	22.88	22.68	22.97
250 kg N/ha	277.5	297.3	270.9	281.9	292.0	330.7	292.3	305.0	1.65	1.79	1.61	1.69	1.65	1.69	1.55	1.63	23.68	23.16	22.64	23.16	22.78	22.32	22.10	22.40
F-test	**	**	**	**	**	**	**	**	**	**	*	**	*	**	**	**	**	**	**	**	**	**	**	**
LSD (5%)	6.7	7.1	8.3	4.1	4.4	6.7	5.3	3.1	0.04	0.05	0.07	0.03	0.05	0.05	0.05	0.03	0.36	0.14	0.23	0.15	0.19	0.14	0.13	0.09
C- N application																								
2 equal portions	245.2	260.8	235.7	247.3	262.8	290.3	248.4	267.2	1.73	1.86	1.69	1.76	1.67	1.76	1.68	1.70	25.28	24.57	24.05	24.64	24.37	23.77	23.58	23.91
3 equal portions	262.4	278.9	250.9	264.1	282.5	312.0	270.5	288.3	1.68	1.83	1.67	1.73	1.63	1.71	1.61	1.65	24.30	23.59	23.07	23.66	23.25	22.85	22.68	22.93
4 equal portions	276.5	288.5	267.3	277.4	289.4	327.2	286.9	301.1	1.66	1.84	1.61	1.71	1.65	1.69	1.56	1.64	23.34	22.55	22.13	22.67	22.38	22.06	21.84	22.10
F-test	**	**	**	**	**	**	**	**	**	NS	*	**	NS	**	**	**	**	**	**	**	**	**	**	**
LSD (5%)	5.8	6.0	16.0	3.4	4.9	4.0	4.4	3.4	0.04	---	0.06	0.03	---	0.03	0.04	0.02	0.15	0.14	0.17	0.14	0.10	0.11	0.10	0.06
Means	261.4	276.1	251.3	262.9	278.2	309.8	268.6	285.5	1.69	1.84	1.66	1.73	1.65	1.72	1.62	1.66	24.31	23.57	23.09	23.66	23.33	22.89	22.70	22.97
F-test		**				**				**				**				**				**		
LSD (5%)		4.6				4.7				0.04				0.03				0.13				0.15		

D1 = 1st Sept. , D2= 1st Oct. and D3= 1st Nov.

Table (3)

Averages of sucrose (%), juice purity (%) and root yield (t/ha) as affected by planting dates, plant populations, N-levels and times of N application during 1994/95 and 1995/96 seasons.

Character	Sucrose %								Juice purity %								Root yield (t / ha)							
Season	1994/95				1995/96				1994/95				1995/96				1994/95				1995/96			
Planting date	D1	D2	D3	Comb	D1	D2	D3	Comb	D1	D2	D3	Comb	D1	D2	D3	Comb	D1	D2	D3	Comb	D1	D2	D3	Comb
A- Plant populations																								
71400 plants/ha	18.84	18.03	17.35	18.07	18.59	18.49	17.55	18.21	75.47	73.89	73.74	74.37	77.48	79.86	76.14	77.83	34.452	39.357	32.619	35.476	37.071	42.286	33.548	37.619
142800 plants/ha	17.41	16.63	16.19	16.74	17.36	16.93	16.56	16.95	76.7	77.45	75.18	76.44	80.36	80.12	78.95	79.81	43.190	50.595	39.690	44.500	45.762	53.929	42.333	47.333
57120 plants/ha	19.51	18.83	18.13	18.83	19.34	19.2	18.44	18.99	74.62	74.06	72.89	73.86	77.45	77.91	75.42	76.93	33.786	37.881	32.381	34.690	34.690	38.714	33.429	35.619
114240 plants/ha	17.98	17.26	16.62	17.29	17.67	17.78	16.74	17.4	77.13	75.4	74.44	75.66	78	78.77	75.16	77.31	44.214	50.905	42.214	45.762	48.452	55.786	44.000	49.405
F-test	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
LSD (5%)	0.14	0.22	0.1	0.08	0.2	0.23	0.18	0.11	0.86	1.45	1.1	0.61	1.34	1.05	1.45	0.68	0.667	0.643	1.095	0.429	0.643	1.524	0.786	0.548
B- N levels																								
150 kg N/ha	18.93	18.23	17.69	18.28	18.72	18.66	17.79	18.39	75.98	76.15	75.61	75.91	78.57	79.53	76.37	78.16	37.214	42.214	34.643	38.024	39.524	45.286	36.167	40.333
200 kg N/ha	18.35	17.66	17.08	17.7	18.19	17.99	17.42	17.87	75.63	75.1	73.87	74.87	78.08	78.7	76.89	77.89	38.929	44.619	36.905	40.143	41.548	47.643	38.476	42.548
250 kg N/ha	18.03	17.18	16.45	17.22	17.82	17.66	16.76	17.41	76.33	74.35	72.71	74.46	78.32	79.26	75.99	77.86	40.571	47.238	38.643	42.143	43.429	50.095	40.333	44.619
F-test	**	**	**	**	**	**	**	**	NS	**	**	**	NS	NS	NS	NS	**	**	**	**	**	**	**	**
LSD (5%)	0.11	0.1	0.18	0.07	0.23	0.12	0.21	0.1	---	0.55	1.26	0.62	---	---	---	--	0.214	0.333	0.976	0.286	0.738	0.810	0.976	0.452
C- N application																								
2 equal portions	18.79	18.03	17.4	18.07	18.57	18.44	17.69	18.23	74.39	73.48	72.38	73.42	76.34	77.62	75.1	76.35	37.238	42.429	35.119	38.262	39.810	45.595	36.690	40.690
3 equal portions	18.44	17.66	17.06	17.72	18.23	18.09	17.32	17.88	75.97	74.94	74.02	74.98	78.51	79.26	76.42	78.06	38.929	44.738	36.952	40.214	41.571	47.690	38.429	42.571
4 equal portions	18.08	17.38	16.76	17.41	17.92	17.77	16.97	17.55	77.58	77.19	75.79	76.85	80.12	80.61	77.74	79.49	40.548	46.881	38.119	41.857	43.095	49.762	39.833	44.238
F-test	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
LSD (5%)	0.09	0.1	0.14	0.07	0.15	0.17	0.15	0.1	0.6	0.61	0.71	0.37	0.77	0.8	0.82	0.46	0.310	0.286	0.714	0.286	0.643	0.905	0.786	0.452
Means	18.44	17.69	17.07	17.73	18.24	18.1	17.32	17.89	75.98	75.2	74.06	75.08	78.32	79.16	76.42	77.97	38.905	44.690	36.714	40.095	41.500	47.690	38.310	42.500
F-test		**				**				**				**				**				**		
LSD (5%)		0.05				0.11				0.53				0.58				0.286				0.510		

D1 = 1[st] Sept. , D2= 1[st] Oct. and D3= 1[st] Nov.

Table (4)

Averages of top and sugar yields (t / ha) as affected by planting dates, plant populations, N-levels and times of N application during 1994/95 and 1995/96 seasons.

Character	Top yield (t / ha)								Sugar yield (t / ha)							
Season	1994/95				1995/96				1994/95				1995/96			
Planting date	D1	D2	D3	Comb.	D1	D2	D3	Comb.	D1	D2	D3	Comb.	D1	D2	D3	Comb.
A- Plant populations																
71400 plants/ha	21.143	22.095	19.881	21.048	22.119	24.476	20.429	22.333	6.476	7.071	5.643	6.405	6.881	7.786	5.857	6.881
142800 plants/ha	28.952	30.119	28.143	29.071	32.095	36.500	30.905	33.167	7.500	8.405	6.405	7.429	7.929	9.119	7.000	8.024
57120 plants/ha	18.262	18.762	17.476	18.167	18.762	20.000	17.929	18.905	6.571	7.119	5.857	6.524	6.690	7.429	6.143	6.762
114240 plants/ha	27.619	28.690	26.000	27.429	29.619	33.000	28.571	30.381	7.929	8.762	7.000	7.905	8.548	9.905	7.357	8.595
F-test	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
LSD (5%)	1.310	0.905	1.095	0.571	0.810	1.286	1.119	0.571	0.095	0.071	0.143	0.048	0.071	0.167	0.119	0.071
B- N levels																
150 kg N/ha.	22.310	23.024	20.881	22.071	23.690	26.286	21.976	23.976	7.000	7.643	6.095	6.905	7.357	8.381	6.381	7.381
200 kg N/ha	24.095	24.905	23.024	24.000	25.786	28.881	24.762	26.476	7.119	7.833	6.262	7.071	7.500	8.524	6.643	7.571
250 kg N/ha	25.571	26.810	24.714	25.714	27.452	30.310	26.643	28.143	7.286	8.071	6.310	7.214	7.690	8.786	6.738	7.738
F-test	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
LSD (5%)	0.762	0.500	0.548	0.333	0.500	0.571	0.524	0.333	0.024	0.048	0.119	0.048	0.071	0.119	0.119	0.048
C- N application:																
2 equal portions	22.500	23.333	21.381	22.405	23.762	26.357	22.429	24.190	6.952	7.595	6.071	6.881	7.333	8.333	6.452	7.381
3 equal portions	24.071	25.048	22.976	24.024	25.738	28.667	24.548	26.310	5.238	7.857	6.262	7.071	7.524	8.571	6.619	7.571
4 equal portions	25.429	26.381	24.286	25.357	27.452	30.452	26.405	28.095	7.286	8.095	6.357	7.238	7.667	8.786	6.714	7.714
F-test	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
LSD (5%)	0.595	0.595	0.643	0.333	0.667	0.571	0.524	0.333	0.048	0.024	0.095	0.048	0.071	0.119	0.095	0.048
Means	24.000	24.929	22.881	23.929	25.643	28.500	24.452	26.190	7.119	7.833	6.238	7.071	7.524	8.571	6.595	7.548
F-test	**				**				**				**			
LSD (5%)	0.381				0.452				0.071				0.119			

D1 = 1st Sept. , D2= 1st Oct. and D3= 1st Nov.

- Interaction effects: The interaction between planting dates and plant populations had significant effects on root fresh weight and root yield ha^{-1} in the two seasons. Planting sugar beets on the first of October on one side of ridges, 25 cm apart (57120 plants ha^{-1}) recorded the highest root fresh weight in the two seasons (Table 5). However, planting beets on first of October on both sides of ridge, 25 cm apart (114240 plants ha^{-1}) produced the highest root yield during the two seasons (Table 5). The interaction between plant populations and nitrogen fertilizer levels had marked effects on root diameter as well as root and sugar yields ha^{-1} in both seasons (Table 6). Planting sugar beets on one side of ridges, 70 cm width and 25 cm apart (57120 plants ha^{-1}) and adding 250 Kg N ha^{-1} recorded the highest root diameter in the two seasons, whereas planting sugar beets on the two sides of ridge, 70 cm width and 25 cm apart (114240 plants ha^{-1}) and adding 250 Kg N ha^{-1} were associated with the highest root and sugar yields ha^{-1} in both seasons.

Table (5)

Averages of root fresh weight (g) plant and root yield (ton ha^{-1}) as affected by the interaction between planting dates and plant populations in 1994 / 95 and 1995 / 96 seasons.

Season	1994 / 95			1995 / 96		
Planting dates	1st Sept	1st Oct.	1st Nov.	1st Sept	1st Oct.	1st Nov.
Population	**Root fresh weight (g) plant**					
71400 plants/ha	489.3	559.9	457.1	520.0	598.3	475.0
142800 plants ha^{-1}	306.1	361.8	280.4	312.8	377.4	295.3
57120 plants ha^{-1}	594.9	669.4	569.4	603.3	684.9	594.0
114240 plants ha^{-1}	390.5	451.9	372.1	413.8	487.1	387.2
F – test	**			**		
LSD at 5 %	5.9			10.2		
	Root yield (ton/ha)					
71400 plants ha^{-1}	34.452	39.357	32.619	37.071	42.286	33.524
142800 plants ha^{-1}	43.190	50.595	39.690	45.762	53.929	42.333
57120 plants ha^{-1}	33.762	37.881	32.381	34.690	38.714	33.429
114240 plants ha^{-1}	44.190	50.905	42.214	48.452	55.786	43.976
F – test	**			**		
LSD at 5 %	0.714			0.906		

Table (6)

Averages of root diameter (cm) as well as root and sugar yields (t ha^{-1}) as affected by the interaction between plant populations and nitrogen fertilizer levels in 1994 / 95 and 1995 / 96 seasons

Seasons	1994 / 95				1995 / 96			
No.of plants ha^{-1}	71400	142800	57120	114240	71400	142800	57120	114240
N-Levels	**Root diameter (cm)**							
150 kg N ha^{-1}	7.7	6.7	8.2	7.3	7.9	6.8	8.4	7.5
200 kg N ha^{-1}	8.8	7.5	9.3	8.1	9.1	7.8	9.6	8.5
250 kg N ha^{-1}	9.9	8.3	10.5	8.9	10.1	8.3	10.6	9.6
F – test	**				**			
LSD at 5 %	0.2				0.1			
N-Levels	**Root yield (t ha^{-1})**							
150 kg N ha^{-1}	33.595	41.643	33.500	43.310	35.690	44.405	34.333	46.857
200 kg N ha^{-1}	35.381	44.619	34.810	45.762	37.381	47.500	35.833	49.500
250 kg N ha^{-1}	37.429	47.214	35.690	48.214	39.810	50.143	36.643	51.857
F – test	**				**			
LSD at 5 %	0.595				0.905			
	sugar yield (t ha^{-1})							
N-Levels	71400	142800	57120	114240	71400	142800	57120	114240
150 kg N ha^{-1}	6.262	7.143	6.571	7.643	6.714	7.643	6.786	8.333
200 kg N ha^{-1}	6.405	7.476	6.476	7.929	6.810	8.024	6.786	8.619
250 kg N ha^{-1}	6.524	7.714	6.500	8.143	7.024	8.381	6.690	8.833
F – test	**				**			
LSD at 5 %	0.095				0.119			

In general, it can be concluded that planting sugar beets on the first October in both sides of ridges, 25 cm apart (114240 plants ha^{-1}) and adding 250 Kg N ha^{-1} into four splitting equal portions (at 45, 60, 75 and 90 days after planting) could be recommended for maximizing sugar beet productivity in the newly reclaimed sandy soils, under the environmental conditions of Kalabsho region, Belkas district, Dakahlia Governorate.

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تأثير مواعيد الزراعة والكثافة النباتية والتسميد النيتروجينى على انتاجية بنجر السكر فى الأراضى الرملية حديثة الإستصـــلاح بجمهورية مصر العربية

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الملخص:

نفذ هذا البحث بأرض رملية حديثة الاستصلاح لدراسة تأثير مواعيد الزراعة والكثافة النباتية و معدلات ومواعيد إضافة السماد النيتروجينى على إنتاجية بنجر السكر "الصنف كواميرا". وقد أفادت نتائج الدراسة أن الكثافة النباتية قد أثرت معنويا على جميع الصفات المقاسة خلال موسمي النمو وأن أعلا محصول من الجذور والسكر قد نتج بزراعة البنجر على جانبي الخط بعرض ٧٠ سم ومسافة ٢٥ سم بين النباتات (١١٤٢٤٠ نبات / هكتار). كما أثر معدل السماد النيتروجيني معنويا على كل صفات الدراسة وأن إضافة ٢٥٠ كجم ن/هكتار قد نتج عنها زيادة معنوية في طول وقطر الجذر ومحصول الجذور والسكر / هكتار خلال موسمي الدراسة. وأشارت النتائج أيضا أن إضافة النيتروجين على أربع دفعات (بعد ٤٥، ٦٠، ٧٥ و ٩٠ يوم من الزراعة) نتج عنها أكبر طول وقطر للجذر ونسبة نقاوة ومحصول الجذور والعرش و السكر / هكتار.

وبصفة عامة توصي الدراسة بزراعة بنجر السكر فى أول شهر أكتوبر على جانبى الخطوط (عرض ٧٠ سم) وعلى مسافة ٢٥ سم بين الجور (١١٤٢٤٠ نبات / هكتار) مع التسميد النيتروجيني بمعدل ٢٥٠ كجم نيتروجين / هكتار تضاف على أربع جرعات متساوية (بعد ٤٥، ٦٠ ، ٧٥ و ٩٠ يوم من الزراعة) لزيادة إنتاجية بنجر السكر تحت ظروف الأرض الرملية بمنطقة الدراسة.