YIELD AND QUALITY OF SUGAR BEET AS AFFECTED BY SOWING DATE, NITROGEN LEVEL AND FOLIAR SPRAYING WITH CALCIUM

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ABSTRACT

Two field experiments were carried out at the Experimental Farm of Sakha Agric. Res. Station at the two successive growing seasons of 2013/2014 and 2014/2015 to study the effect of planting date, nitrogen level and foliar spraying with calcium on yield and quality of sugar beet. Split – split plot design was used in both seasons. Main plots contained the two sowing dates (on 20 September, 18 October 2013 in the first season and on 25 September, 29 October in the second season) and three nitrogen levels (80, 90 and 100 kg N/fad.) were arranged in sub-plot whereas, the two calcium rates (0 and 2 g/l.) were randomly distributed in sub– sub –plots. All treatments were replicated three replications. Important findings could be summarized as follows:

Resulted indicated that sowing sugar beet at early sowing date (on September) significantly increased root dimension, root/top ratio, top yield as well as root, sugar yields and extractability%.

Application of nitrogen at the rate of 100 N/fad. significantly increased both root dimension, top, root and sugar yields. On the other hand, increasing N rate up to 100 kg N/fad. tended to decrease both root/top ratio, purity%, TSS% as well as sucrose and sugar losses in molas percentages.

Foliar spraying with calcium significantly affected root dimensions, top, root and sugar yields as well as extractability% and TSS%.

INTRODUCTION

Sugar beet crop (*Beta vulgaris,* L.) considered the important source for sugar after sugar cane in Egypt as well as in the world. Many of cultural practices such as sowing date, nitrogen fertilizer are very important factors, which limiting sugar production from sugar beet in addition to spraying with calcium element, which have important role in plant physiology and cell structure.

Sowing date at suitable time is very important to obtained higher yield and quality as sowing on September under Egyptian conditions. Srivastava and Singh (1981); Hanna *et al.* (1988) and Nemeat Alla (2007) concluded that planting sugar beet on October surprising than planting on other dates in most sugar beet characters i.e., root weight, root yield and sugar yield.

Nitrogen fertilizer rate playing an limiting factor for sugar production of sugar beet. Increasing nitrogen rate had a reflection effect or inversion effect on quality characters as, sucrose and purity

as well as extractability% and total soluble solids %, Lalia *et al*. (2005). Whereas, increasing nitrogen rate tended to increase top, root, sugar yields, Sadre *et al.* (2012), Salim *et al* (2012), Gomea *et al.* (2013) and EL-Sarag and Moselhy (2013) found that increasing nitrogen rate increased root, top and sugar yields. While it decreased sugar beet quality in the same time.

Application of calcium element to sugar beet as foliar spraying with enough amount had significant effect on top yield, root yield and sugar yield. Biaczyk (2005) and Artysza *et al.* (2014) reported that Calcium significantly increased root yield by 13.1% and top yield by about 21% and biological sugar yield by about 15.5% .

This study was aimed to limited the optimum sowing date and the optimum rate of nitrogen with suitable calcium dose as foliar application to obtained maximum sugar beet yield and quality under the conditions. of Kafer EL-Sheikh Governorate.

MATERIALS AND METHODS

Two series of field experiments were conducted at the Experimental Farm of Sakha Agric. Res. Station during two successive seasons, 2013/2014 and 2014/2015. The preceding crop was corn in the two seasons. Chemical analysis of experimental soils in the two seasons are presented in Table (1).

Table (1): Chemical analysis of soil experimental site (0-30 cm in depth) of the Experimental Farm of Sakha Agric. Research Station in (2013/2014 and 2014/2015) seasons

Season	PH 1:2.5	EC dS/m	Organic matter%	Available			Anions Meq/L.			
				N ppm	P ppm	K ppm	HCO_3-	Cl-	SO_4-	CO_3-
2013/2104	8.3	3.42	1.85	16.14	6.22	288.11	6.2	5.6	0.15	0.0
2014/2015	8.5	3.38	1.78	15.76	6.31	282.25	6.5	6.2	0.19	0.0

The experimental soils was fertilized with 24 kg K_2O/fad in form of potassium sulphate (48% K_2O) during land preparation.

A split – split plot design with three replications was used. The main plots were assigned by the two sowing dates (September and October) and the sub plots contained nitrogen levels, (80, 90 and 100 kg N/fad.), while calcium fertilizer as foliar application was randomly distrusted in the sub sub plots in both seasons.

Each sub-sub plot included six ridges 55cm apart and 7m. long. Sowing took place on 20 September, 18 October 2013 in the first season and on 25 September, 29 October in the second season.

Seed of multigerm cultivar "Byramide " was sown in hills 20 cm apart at rate of 3-4 seeds per hill. Plants were thinned to one plant per

hill at four true leaves stage. Nitrogen fertilizer in from of Urea (46% N) with mentioned rates were added in two equal doses. The first one was applied after thinning and the other one after one month later. Solution of calcium sulphate at the rate of (2g/l) and distilled water were sprayed after 65 days from sowing. The other cultural practices were done as recommended.

At maturity (205 days from sowing), the area of four guarded ridges were harvested to determine top and root yields, as well as quality of beets. Sample of ten guarded plants were taken at random to estimate root dimension (length and diameter). Concerning the quality as total soluble solids (T.S.S) percentage was determined with hand refractometer, sucrose percentage was determined using the method described by Le Docte (1927) and Mc Ginnus (1971).

Non soluble sugar in term of impurities (K and Na element) were determined using flame photometer according to Brown and Lilliand (1964) and α – amino N was determined using ninhydrin and hydrindantin method according to Carruthers *et al.* (1962).

- Purity percentage = 99.36 – {14.27 (v1+v2+v3/v4).
  Where:
  V_1 = Sodium % V_2 = Potassium %
  V_3 = α – amino N % V_4 = Sucrose % (Pol%)
- Sugar losses to molasses (SM) = (v1+v2) 0.14+v3×0.25+0.5 Deviller (1988).
- Extractable sugar % = v4 – SM – 0.6 Dexter *et al.* (1967).
- Extractability % = Extractable / sucrose %.
- Alkalinity coefficient = v1+v2/v3 Harvey and Dutton (1993).
- Sugar yield (ton/fad.) = root yield × sucrose % × purity %.

The analysis of variance was carried out according to Gomez and Gomez (1984). Treatment means were compeered by Duncan's maltiple range test (Duncan, 1955). All statistical analysis were performed using analysis of variance technique by means of "Cohort" computer software package.

RESULTS AND DISCUSSION

Root dimensions:

Root dimensions (length and diameter) as affected by sowing date, nitrogen rate and foliar spraying with calcium in 2013/2014 and 2014/2015 seasons are presented in Table (2).

Sowing date significantly affected root length and root diameter in both seasons, Table (2). First sowing date increased root dimensions (length and diameters) compared with second sowing. Similar results were obtained by Mahmoud *et al.*(1999), EL – Kassaby and Leilah (1992) and Bassal *et al.*(2001).

Nitrogen fertilizer level had a significant effect on root dimensions (length and diameter) at harvest in both seasons. The highest values of root length and diameter were recorded at 100 kg N / fad. These results are in agreement with those of Abd EL – Hadi *et al.*(2002), Ismail and Ghait (2005) and Nemeat Alla *et al.* (2014).

The obtained results showed clearly that dimension was increased with spraying of calcium in both seasons. The highest values of root length 33.04 and 33.11 cm as well as root diameter 9.77 and 10.67 cm. Were recorded with plants sprayed with calcium at 2g/l. in 2013/2014 and 2014/2015 seasons, respectively. The increase in root dimensions due to spraying with calcium may be attributed to increasing in cell number and size. These results are in harmony with those obtained Nemeat Alla (2009).

Table (2): Root length (cm), root diameter (cm) and root/top ratio as affected by sowing date, nitrogen rate and foliar application of calcium in 2013/2014 and 2014/2015 seasons

Factor	Root length (cm)		Root diameter (cm)		Root/Top ratio%	
	seasons					
	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15
Sowing date (S):						
First date	43.12a	33.95a	10.42a	11.46a	3.11b	2.93b
Second date	31.44b	31.76b	8.81b	9.47b	3.75a	3.61a
F- test	**	**	**	**	**	**
N- Fertilizer rate (kg N/fad.) (N):						
80	31.71c	32.04c	9.08c	9.71c	3.51a	3.39a
90	32.58b	32.81b	9.58b	10.48b	3.47b	3.31b
100	34.05a	33.71a	10.19a	11.21a	3.30c	3.10c
F- test	**	**	**	**	**	**
Foliar app. of calcium (2g/l) (F):						
0	32.52b	32.59b	9.46b	10.26b	3.43	3.29
2	33.04a	33.11a	9.77a	10.67a	3.42	3.25
F- test	**	**	**	**	NS	NS
Interaction:						
S × N	**	**	NS	**	**	**
S × F	NS	**	NS	**	*	NS
N × F	NS	NS	NS	NS	*	NS
S × N × F	**	*	NS	NS	NS	NS

* and N.S indicated P<0.05 and not significant, respectively. Means within the same column for each factor designed by the same letter are not significantly different at 5% level according to Duncan‘s multiple range test.

Data presented in Table (2-a1) show that early sowing gave the highest root length (35.90 and 36.07cm.) when sugar beet plants fertilized with maximum N rate 100 kg N/fad. in both seasons.

Table (2-a1): Root length (cm) as affected by the interaction between sowing date and nitrogen rate in 2013/2014 and 2014/2015 seasons

Sowing date	N. rate (kg N/ fad.)		
	80	90	100
2013/2014			
First date	32.80c	33.65b	35.90a
Second date	30.62f	31.50e	32.20d
2014/2015			
First date	32.99c	33.80b	36.07a
Second date	31.10f	31.82e	32.35d

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

As for the second order, the interaction among sowing date × nitrogen rate × foliar application of calcium data in Table (2-a2) pointed out that sowing sugar beet plants at early sowing date (September) and fertilized with 100 kg N/fad under foliar application of calcium at rate of (2g/l) produced the highest root length in both seasons.

Table (2-a2): Root length (cm) as affected by the interaction among sowing date, N-rate and foliar application of calcium in 2103/2014 and 2014/2015 seasons

Sowing date	Foliar of calcium (2g/l)	N. rate (kg N / fad.)		
		80	90	100
2013/2014				
First date	0	32.60f	33.40d	35.47b
	2	33.00e	33.90c	36.33a
Second date	0	30.30l	31.27j	32.07h
	2	30.93k	31.73i	32.33g
2014/2015				
First date	0	32.77f	33.53d	34.60b
	2	33.20e	34.07c	35.53a
Second date	0	30.80l	31.70j	32.17h
	2	31.40k	31.93i	32.53g

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

Root/top ratio:

Root/top ratio considered as indicator to optimum time for harvest of sugar beet. Data tabulated in Table (2) presented the effect of sowing date, nitrogen level and foliar application of calcium on root/top ratio.

Results in this Table showed that planting date had a significant effect in the only second season. Planting sugar beet at early date gave a good chance to increase top growth rate than root and gave lowest values compared to postponing sowing, which gave chance to root to increase in growth rate than top and gave the highest

root/top ratio . These results were in agreement with those obtained by Leilah *et al.* (2005).

As effect of nitrogen level on this trait, data in Table (2) show a significant effect on root/top ratio only in the second season. Increasing N-level gradually decreased root/top ratio in the second season. In the first season, increasing N- level tended to decrease root/top ratio but the differences did not reach the 5% level of significant. Similar results were found by Nemeat Alla *et al. (2007)* and Nemeat Alla (2009).

As respect to effect of calcium application as foliar on root/top ratio, data in Table (2) pointed out that spraying with calcium at rate of 2g/l. exhibited no significant effect on both seasons. These results coincided with those stated by Nemeat Alla (2009).

The interaction effect between sowing date × N rate was significant in both seasons Table (2-a3). Maximum ratio for root/top was found when sugar beet was sowing early on 20 September in 2103 and on 25 September in 2104 and fertilized with 100 kg N/fad. This was true in both seasons.

Table (2-a3): Root/top ratio as affected by the interaction between sowing date and nitrogen rate in 2013/2014 and 2014/2015seasons

Sowing date	N. rate (kg N/ fad.)		
	80	90	100
2013/2014			
First date	3.14d	3.11de	3.07e
Second date	3.88a	3.83b	3.53c
2014/2015			
First date	3.12c	2.93d	2.75e
Second date	3.70a	3.67a	3.46b

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

Top, root and sugar yields (t/fad.):

The final goal for sugar beet cultivate is the highest values of top, root and sugar yields. Data in Table (3) showed clearly that sowing date had a significant affect on these three traits in both seasons. Planting sugar beet at early sowing date (on 20 September in 2103 and on 25 September in 2104) gave the highest values in both seasons (8.89, 8.81, 27.60, 25.88 and 5.13, 4.92 t/fad.) from top, root and sugar yields/fad., respectively.

Table (3): Top, Root yield and sugar yields (t/fad.) as affected by sowing date, nitrogen rate and foliar application of calcium in 2013/2014 and 2014/2015 seasons

Factor	Top yield (t/fad.)		Root yield (t/fad.)		sugar yield (t/fad.)	
	seasons					
	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15
Sowing date (S):						
First date	8.89a	8.81a	27.60a	25.88a	5.13a	4.92a
Second date	6.39b	6.95b	23.84b	22.98b	4.47b	4.39b
F- test	**	**	**	**	**	**
N-Fertilizer rate (kg N/fad.) (N):						
80	6.71c	6.64c	23.17c	22.49c	4.60c	4.50c
90	7.49b	8.00b	25.51b	24.28b	4.80b	4.64b
100	8.73a	8.81a	28.48a	26.54a	4.90a	4.82a
F- test	**	**	**	**	**	**
Foliar app. of calcium (2g/l) (F):						
0	7.50b	7.71b	25.21b	24.08b	4.76b	4.63b
2	7.79a	8.06a	26.23a	24.79a	4.83a	4.68a
F- test	**	**	**	**	**	*
Interaction:						
S × N	**	**	**	NS	**	**
S × F	NS	NS	**	NS	**	NS
N × F	NS	NS	**	NS	NS	NS
S × N × F	**	*	**	NS	*	NS

* and N.S indicated P<0.05 and not significant, respectively. Means within the same column for each factor designed by the same letter are not significantly different at 5% level according to Duncan's multiple range test.

These observations were accordance with those found by Srivastava and Singh (1981), Hanna *et al.* (1988), Kandil *et al* (2002), Leilah *et al* (2005) and Refay (2010).

Regarding to effect of nitrogen rate on top, root and sugar yields, data presented in Table (3) pointed out that all of these mentioned traits (top, root and sugar yields) were significantly increased with increasing nitrogen rate from 80 to 100 kg N/fad. Each increment of nitrogen fertilizer resulted in a significant increase in top, root and sugar yields. This fact was true in both seasons. These significant increases among mean values of these traits may be due to physiological role of nitrogen in increasing photosynthesis rate and crop growth rate by increasing cell size (elongate and number) for root and top of beet plants, which reflected on higher increase in yields of top, root and sugar in both seasons. These results are in harmony with those obtained by Kandil *et al.* (2002), Leilah *et al.* (2005), El-Sarag and Moselhy (2013), and Gomaa *et al*. (2013).

As for the effect of foliar application of calcium on top, root and sugar yields of sugar beet, significant differences were observed between mean values in both seasons, Table (3). Application of calcium element to sugar beet as foliar at the rate of 2 g/l. gave maximum yields of top, root and sugar in both seasons. These advantage resulted from application of calcium to sugar beet may be due to his important role in normal photosynthesis activity of sugar beet leaves, which caused in sugar beet healthy roots. Similar results were found by Biaczyk (2005), Nemeat Alla (2009) and Artyszak *et al.* (2014). The interaction effects between sowing date × nitrogen rate on top yield showed significant effects on top yield in both seasons as shown in Table (3-a1). The highest values of top yields were obtained from early sowing under 100 kg N/fad in both seasons.

Table (3-a1): Top yield (t/fad.) as affected by the interaction between sowing date and nitrogen rate in 2013/2014 and 2014/2015 seasons

Sowing date	N- rate (kg N / fad.)		
	80	90	100
2013/2014			
First date	7.67c	8.79b	10.21a
Second date	5.74f	6.19e	7.25d
2014/2015			
First date	4.48d	9.23b	9.73a
Second date	6.19f	6.78e	7.89c

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

Significant interaction effects were found on top yield/fad. resulted from the interaction among the three factors under study, Table (3-a2).

Table (3-a2): Top yield (t/fad.) as affected by the interaction among sowing date, foliar application of calcium and nitrogen rate in 2103/2014 and 2014/2015 seasons

Sowing date	Foliar of calcium (2g/l)	N-rate (kg N / fad.)		
		80	90	100
2013/2014				
First date	0	7.56f	8.58d	10.02b
	2	7.78e	8.99c	10.41a
Second date	0	5.57l	6.08j	7.16h
	2	5.91k	6.29i	7.33g
2014/2015				
First date	0	7.17f	9.09c	9.63a
	2	7.79e	9.36b	9.83a
Second date	0	6.06i	6.55g	7.75e
	2	6.32h	7.01f	8.04d

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

Data show that sowing sugar beet at early date and fertilized with 100 kg N/fad. under application of calcium at the rate of 2 g/l. recorded the highest values of top yield (10.41 and 9.83 t / fad.

Significant interaction effects were found in both seasons on sugar yield/fad., which resulted from combination between sowing date × nitrogen level. Table (3-a3). Maximum sugar yield /fad. was obtained (5.48 and 5.08 t /fad.) from the interaction between early sowing date and 100 kg N/ fad.

Table (3-a3): Sugar yield (t/fad.) as affected by the interaction between sowing date and nitrogen rate in 2013/2014 and 2014/2015 seasons

Sowing date	N- rate (kg N / fad.)		
	80	90	100
2013/2014			
First date	4.81c	5.09b	5.48a
Second date	4.02e	4.50d	4.50d
2014/2015			
First date	4.81c	4.87b	5.08a
Second date	4.20f	4.31e	4.56d

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

Impurities (Na, K and α amino N) soluble non sugar (meq/100g beet):

Containing sugar beet root low impurities values is very important to obtained good quality from sugar beet. So, this investigation tried to reduce these values to improve sugar beet root quality. The present data in Table (4) show that sowing date had no significant effect on impurities values (Na, K and α amino N) in both seasons, except that K- content in the second season.

Concerning the effect of nitrogen fertilizer level on impurities (Na, K and α-amino nitrogen), highly significant differences were observed among values of impurities in both seasons, Table (4).

Table (4): Na, K and α-N as affected by sowing date, nitrogen rate and foliar application of calcium in 2013/2014 and 2014/2015 seasons

Factor	Na (meq/100g beet)		K (meq/100g beet)		α-N (meq/100g beet)	
	seasons					
	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15
Sowing date (S):						
First date	1.75	1.48	6.26	6.21b	2.32	2.24
Second date	1.72	1.53	6.25	6.34a	2.36	2.35
F- test	NS	NS	NS	**	NS	NS
N-Fertilizer rate (kg N/fad.) (N):						
80	1.48c	1.33c	6.01c	5.99c	1.51c	1.48c
90	1.60b	1.50b	6.25b	6.31b	2.22b	2.28b
100	2.13a	1.69a	6.50a	6.51a	3.30a	3.13a
F- test	**	**	**	**	**	**
Foliar app. of Calcium (2g/l) (F):						
0	1.67b	1.44b	6.17b	6.20b	2.15b	2.13b
2	1.80a	1.56a	6.34a	6.34a	2.53a	2.46a
F- test	**	**	**	**	**	**
Interaction:						
S × N	NS	NS	**	NS	NS	NS
S × F	**	NS	**	NS	NS	NS
N × F	**	NS	**	NS	NS	**
S × N × F	**	NS	NS	NS	**	NS

* and N.S indicated P<0.05 and not significant, respectively. Means within the same column for each factor designed by the same letter are not significantly different at 5% level according to Duncan's multiple range test.

Concerning the effect of nitrogen fertilizer levels on impurities (Na, K and α amino N) highly significant differences were observed between values of impurities in both seasons Table (4).

Application high nitrogen rate 100 kg N/fad. led to significant increase in all impurities values in both seasons, which caused a bad effect in sugar beet quality. These observations were found by Nemeat Alla (2009) and Sharaf (2012).

As for effect of calcium application as foliar spray on sugar beet, data in Table (4) clear that application of calcium as foliar spraying at 2g/l significantly increased impurities values in both seasons.

No significant interaction effects were found among the three factors under study on most impurities characters in both seasons. Whereas, some significant effects were found in one season in some characters without other.

The interaction effect between the three studied factors on impurities were not significant in both seasons except on K resulted

from (sowing date × N levels) in both seasons and on Na between (N levels × foliar spraying calcium) and between the three factors (S × N × F) on Na and K in the first season only, Table (4).

Alkaline coefficient, purity% and sugar %:

Results in Table (5) pointed out that sowing date significantly affected alkaline coefficient in the first season as well as purity % and sugar% in the second season only. In respect to influence of nitrogen fertilizer levels (80, 90 and 100 kg N/ fad.), obtained results showed that significant difference were found between mean values of alkaline coefficient. Purity % and sucrose % in both seasons. Increasing nitrogen level from 80 to 100 kg N/fad significantly decreased all values of alkaline coefficient, purity% and sucrose% in the two seasons. It could be noticed that alkaline coefficient values must be not decreased than 1.8 because if its values decrease than 1.8 this indicator to there is depletion in amount of nitrogen application, which produced bad quality of sugar beet roots by having α- amino N with huge amount, which prevent sucrose from crystallization and reduce sugar extractable in the final.

Table (5): Alkaline coefficient, purity % and sugar percentage as affected by sowing date, nitrogen rate and foliar application of calcium in 2013/2014 and 2014/2015 seasons

Factor	Alkaline coefficient		Purity%		Sugar percentage	
	seasons					
	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15
Sowing date (S):						
First date	3.77a	3.74	92.04	92.63a	20.30	21.12a
Second date	2.72b	3.65	92.09	92.22b	20.38	20.53b
F- test	*	NS	NS	**	NS	**
N- Fertilizer rate (kg N/fad.) (N):						
80	5.04a	4.98a	93.33a	93.51a	21.31a	21.50a
90	3.56b	3.48b	92.30b	92.45b	20.37b	20.85b
100	2.63c	2.63c	90.56c	91.32c	19.35c	20.14c
F- test	**	**	**	**	**	**
Foliar app. of calcium (2g/l) (F):						
0	4.03a	3.93a	92.37a	92.69a	20.52a	21.00a
2	3.46b	3.46b	91.76b	92.17b	20.16b	20.66b
F- test	**	**	**	**	**	**
Interaction:						
S × N	NS	NS	NS	*	**	**
S × F	*	NS	NS	NS	NS	NS
N × F	**	**	**	NS	NS	NS
S × N × F	**	NS	NS	NS	NS	NS

* and N.S indicated P<0.05 and not significant, respectively. Means within the same column for each factor designed by the same letter are not significantly different at 5% level according to Duncan's multiple range test.

Similar findings were found by Leilah *et al*. (2005) and Sharaf (2102). Concerning to effect of foliar spraying with calcium to sugar beet plants, data in Table (5) show that addition of calcium at rate of 2g/l. as foliar spray exhibited significant decrease in the three characters in both season. These results are in harmony with Artyszak *et al.* (2014).

The interaction between N level and foliar application of calcium significantly affected by alkaline coefficient in both seasons as shown in Table (5-a1). The highest values of alkaline coefficient was recorded when sugar beet plants fertilized with 80 kg N/fad and sprayed with distilled water (control) in the two seasons.

Table (5-a1): Alkaline coefficient as affected by the interaction between N-level and foliar application of calcium in 2013/2014 and 2014/2015 seasons

Foliar app. of calcium (2g/l)	N- rate (kg N/ fad.)		
	80	90	100
2013/2014			
0	5.54a	3.83c	2.72e
2	4.55b	3.30d	2.54e
2014/2015			
0	5.32a	3.79c	2.69e
2	4.65b	3.16d	2.57e

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

The interaction between sowing date× nitrogen rate resulted in a significant effect on sugar percentage in both seasons, Table (5-a2). The highest values of sucrose% were obtained from early sowing and in the two season 80 kg N/fad.

Table (5-a2): Sucrose % as affected by the interaction between sowing date and nitrogen rate in 2013/2014 and 2014/2015 seasons

Sowing date	N- rate (kg N / fad.)		
	80	90	100
2013/2014			
First date	21.42a	20.17d	19.31e
Second date	21.20b	20.56c	19.39e
2014/2015			
First date	21.73a	21.27b	20.37c
Second date	21.27b	20.42c	19.91d

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

Extractable Sugar, extractability and sugar losses percentages:

Sowing date exhibited significant differences in extractable sugar, extractability and sugar losses% only in the seconded season, Table (6). The first sowing date recorded the highest values of sugar extractable and extractability %, while the second sowing date gave the highest values of sugar losses%. Similar results were obtained by Nemeat Alla (2009) and Sharaf (2012).

Increasing N-level up to 100 kg N/ fad. significantly decreased extractable sugar and extractability %, while it significantly increased sugar losses% in both seasons, Table (6). These results may be due to bad effect for over fertilization with nitrogen which caused on increase in root content from nitrogen, which resulted in losses of sugar in molasses during industrial stage in Factories. These results are agreement with those obtained by Abou Shady *et al.* (2011) and Sharaf (2012). Foliar application of calcium at the rate of 2g/l resulted in a significant reduction in extractable sugar and extractability %, while it increased sugar losses% in the two seasons of study, Table (6).Nemeat Alla (2009) came to the same results.

Table (6): Extractable sugar%, Extractability%, sugar losses% and Total soluble solids% as affected by sowing date, nitrogen rate and foliar application of calcium in 2013/2014 and 2014/2015 seasons

factor	Extractable sugar%		Extractability%		sugar losses%		TSS%	
	seasons							
	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15
Sowing date (S):								
First date	17.50	18.39a	86.11	87.01a	2.20	2.13b	22.00a	21.95a
Second date	17.58	17.74b	86.16	86.37b	2.21	2.19a	21.19b	20.43b
F-test	NS	**	NS	**	NS	*	**	**
N-fertilizer rate (kg N /fad.) (N):								
80	18.78a	19.00a	88.14a	88.39a	1.92c	1.90c	22.72a	21.81a
90	17.61b	18.08b	86.47b	86.73b	2.15b	2.16b	21.85b	21.21b
100	16.22c	17.11c	83.80c	84.94c	2.53a	2.43a	20.32c	20.55c
F-test	**	**	**	**	**	**	**	**
Foliar app. of calcium(2g/l) (F):								
0	17.79a	18.30a	86.60a	87.08a	2.13b	2.10b	21.96a	21.37a
2	17.29b	17.83b	85.67b	86.29b	2.27a	2.22a	21.53b	21.00b
F-test	**	**	**	**	**	**	**	**
Interaction:								
S × N	*	**	*	*	NS	NS	NS	NS
S × F	NS	NS	NS	NS	NS	NS	*	NS
N × F	*	NS	**	NS	**	NS	**	**
S × N × F	NS	NS	NS	NS	*	NS	**	**

* and N.S indicated P<0.05 and not significant, respectively. Means within the same column for each factor designed by the same letter are not significantly different at 5% level according to Duncan's multiple range test.

The interaction between sowing date × nitrogen level Significantly affected extractable sugar in both seasons, Maximum values extractable sugar% (18.90 and 19.26 %) were obtained from early sowing date application of nitrogen fertilizer ate rate of 80 kg N/fad. in the first and second seasons, respectively as shown in Table (6-a1).

Table (6-a1): Extractable sugar % as affected by the interaction between sowing date and nitrogen rate in 2013/2014 and 2014/2015 seasons

Sowing date	N-rate (kg N / fad.)		
	80	90	100
2013/2014			
First date	18.90a	17.42d	16.18e
Second date	18.66b	17.81c	16.26e
2014/2015			
First date	19.26a	18.54c	17.37e
Second date	18.76b	17.62d	16.85f

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

Significant interaction effects between sowing date × nitrogen level on extractability % were found in both seasons as shown in Table (6). The highest values of extractability % were observed when sugar beet plants received 80 kg N/fad under early sowing date, Table (6-a2)

Table (6-a2): Extractability % as affected by the interaction between sowing date and nitrogen rate in 2013/2014 and 2014/2015 seasons

Sowing date	N- rate (kg N/ fad.)		
	80	90	100
2013/2014			
First date	88.22a	86.60c	83.84e
Second date	88.06b	86.35d	83.77f
2014/2015			
First date	88.58a	87.18c	85.28e
Second date	88.19b	86.29d	84.69f

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

Total soluble solids (T.S.S).

Average of total soluble solids in term (T.S.S) as affected by planting date, nitrogen level and foliar spraying with calcium and their interaction effects in the two growing seasons 2013/2014 and 2014/2015 are presented in Table (6).

Sowing date had a significant effect on (T.S.S) in both seasons. Early sowing date significantly increased T.S.S%. Nemeat Alla *et al*. (2007) found similar results.

Data presented in Table (6) show that there were highly significant differences in obtained (T.S.S) in both growing seasons. The highest T.S.S. values (22.72 and 21.81%) by 80 kg N/fad. compared to the lowest (T.S.S) values which resulted from addition 100 kg N /fad. (20.23 and 20.55 %)in two seasons of study,. This was fairly true in both seasons these results were obtained by Nemeat Alla *et al.* (2007) and Gomaa *et al*. (2013).

Application of calcium at the rate of 2g/l as foliar spray exhibited significant reduction in T.S.S as compared to control treatment and gave the lowest T.S.S (21.23 and 21.00 %) in the first and second seasons, respectively. Similar results were stated by Nemeat Alla (2009).

Significant interaction effects on T.S.S. were found between N-rate × foliar applications of calcium in both seasons, Table (6). Maximum values of T.S.S. were obtained with 80 kg N/fad. × Control (spraying sugar beet plants with distilled water), Table (6-a3).

The interaction among the three factors under study significantly affected by T.S.S. % in both seasons as shown in Table (6). Data present in Table (6-a4) show clearly that sowing sugar beet on early sowing date with 80 kg N/fad. under foliar spraying with distilled water (control treatment) recorded the highest T.S.S. in the two seasons.

Table (6-a3): T.S.S. % as affected by the interaction between N-rate and foliar application of calcium in 2013/2014 and 2014/2015seasons

Foliar pp. of calcium (2g/l)	N- rate (kg N / fad.)		
	80	90	100
2013/2014			
0	22.83a	22.29c	20.77e
2	22.60b	21.42d	19.68f
2014/2015			
0	22.06a	21.28c	20.79e
2	21.57b	12.14d	20.32f

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

Table (6-a4): T.S.S. % as affected by the interaction among sowing date, N-rate and foliar application of calcium in 2103/2014 and 2014/2015 seasons

Sowing date	Foliar of calcium (2g/l)	N-rate (kg N / fad.)		
		80	90	100
2013/2014				
First date	0	23.24a	22.79b	21.30f
	2	23.08a	21.80e	19.82i
Second date	0	22.42c	21.80e	20.24h
	2	22.12d	21.03g	19.54j
2014/2015				
First date	0	22.69a	22.06c	21.73d
	2	22.23b	22.00c	21.01f
Second date	0	21.42e	20.50g	19.84i
	2	20.01f	20.27h	19.63j

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

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الملخص العربي

تأثر محصول وجودة بنجر السكر بمواعيد الزراعة والتسميد النيتروجيني وكذلك الرش بالكالسيوم

هيثم السيد أحمد نعمت الله
معهد بحوث المحاصيل السكرية – مركز البحوث الزراعية – الجيزة

اقيمت تجربتان حقليتان في المزرعة البحثية لمحطة بحوث سخا الزراعية بكفر الشيخ – جمهورية مصر العربية في الموسمين الزراعيين 2014/2013 ، 2015/2014 بغرض دراسة تأثير كلا من مواعيد الزراعة في شهري (سبتمبر – اكتوبر) ومعدلات التسميد النيتروجيني (80 ، 90 ، 100 كجم نيتروجين /الفدان) وكذلك معدلين من الرش بعنصر الكالسيوم (صفر – 2 جم كالسيوم / اللتر) علي محصول وجودة بنجر السكر. وقد زرعت هذه المعاملات في تصميم القطع المنشقة مرتين ، حيث وضعت مواعيد الزراعة في القطع الرئيسية ومعدلات التسميد النيتروجيني في القطع الشقية الاولي واما معدلات الرش بالكالسيوم فقد وزعت عشوائيا في القطع الشقية الثانية وكل هذه المعاملات تم تنفيذها في ثلاثة مكررات وتتلخص أهم النتائج المتحصل عليها فيما يلي:

أدت الزراعة المبكرة لمحصول بنجر السكر في شهر سبتمبر الي زيادة معنوية في كل طول الجذر ، قطر الجذر ، نسبة الجذر الي العرش ، محصول العرش ، محصول الجذور ، مجصول السكر وكذلك نسبة الاستخلاص للسكر اذا ما قورن ميعاد الزراعة هذا بالميعاد الأخر في شهر اكتوبر .

أدت زيادة معدلات النيتروجين حتي 100 كجم نيتروجين / الفدان الي زيادة معنوية في كل من طول وقطر الجذر وكذلك محصول الفدان لكل من العرش ، الجذر ، السكر مقارنة بالمعدلات الاخري الاقل. وكان لهذه الزيادة في المعدل حتي 100 كجم نيتروجين / الفدان تاثير عكسي بالسلب او بالنقص في علي كل من نسبة العرش / الجذر ، نقاوة العصير ، نسبة المواد الصلبة الذائبة الكلية في الجذور وكذلك اهم صفات الجوده للبنجر وهي نسبة السكروز في الجذر.

اما اضافة الكالسيوم رشا علي اوراق بنجر السكر فقد ادت الي زياده معنوية في قيم طول وقطر الجذر وكذلك محصول الفدان العرش والجذور والسكر ونسبة الاستخلاص للسكروز من الجذور ونسبة المواد الصلبة الذائبة الكلية في عصير جذور بنجر السكر وذلك عند مقارنتها بالكنترول.

وتشير الدراسة الي اهمية الزراعة المبكرة في شهر سبتمبر والتسميد بمعدل 100 كجم نيتروجين / الفدان وكذلك الرش بعنصر الكالسيوم بمعدل 2جم كالسيوم / اللتر تحت ظروف هذا البحث الذي اجري في محافظة كفر الشيخ.