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EFFECT OF NITROGEN RATES AND ITS TIME OF APPLICATION ON PRODUCTIVITY OF SUGAR BEET UNDER SPRINKLE IRRIGATION IN NEWLY RECLAIMED SOILS

Mahmoud, E. A. and M.I.Masri
Agronomy Department, Faculty of Agric., Cairo Univ., Giza, Egypt

ABSTRACT

Two field experiments were conducted at Sedment El-Gabal location, Beni-Sweif Governorate during 2007/2009 seasons to study the response of sugar beet yield and some of its attributes under sprinkle irrigation to different N rates; 100, 120, 140 and 160 kg N/fed and its time of application viz., split application in two equal doses, at 4- and at 8-leaf stage, or in three equal doses, 1/3 at 4- leaf stage, 1/3 at 8-leaf stage and 1/3 three weeks later, or dividing the rate into 4 equal doses and added 1/4 at 4- leaf stages, 1/4 at 8- leaf stage, 1/4 three weeks later and 1/4 three weeks after the last. A split plot design with four replications was used, where N rates were allocated in the main plots and time of N application was distributed at random in the subplots.

Results obtained from this study revealed that increasing N rates from 100 up to 160 kg N/fed significantly increased root weight by 16.52% and 24.77%, number of plants at harvest by 4.05 and 2.89 thousand plants/fed and root yield by 7.22 and 8.34 tons/fed in the first and second seasons, respectively. Excessive N rate lowered beet quality in terms of sucrose content, juice purity and extractable sucrose. Extractable sugar yield increased by increasing N rates from 100 to 120 Kg/fed. Such increase amounted to 29.08 % in the first season and 31.97 % in the second one. Additional increasing in nitrogen rate beyond 120 kg N/fed had no significant effect on sugar yield.

Splitting N rate into 4 equal doses significantly increased weight of individual root and number of plants/fed at harvest. Late N application in favour of N splitted into 4 doses gave the highest root yield/fed. On the other hand, early application and splitting N in two equal doses at 4-and at 8-leaf stage improved beet quality traits in terms of sucrose %, purity % and extractable sucrose %.

Splitting 160 kg N/fed into 4 equal doses gave the highest root yield, while splitting 120 kg N/fed into 4 equal doses was recommended for high sugar yield/fed.

Keywords: *Beta vulgaris* L., Sprinkle irrigation, N rate, Time of application, Quality traits, Sugar yield

INTRODUCTION

The proper management of nitrogen fertilizer is a major factor in maximizing the production of sugar beet (*Beta vulgaris* L.). Supplies of N must be readily available during early and mid-season in order to promote root and top growth. However, beet plants must become deficient in N prior to harvest to attain the maximum sucrose concentration (Lauer, 1995). Widely different optimum rates of N have been reported in the literature. Halverson and Hartman (1980) reported that optimum rates as high as 390 Kg/ha, while Carter and Traveller (1981) found that the optimum N level was 240 Kg/ha. Kamel *at el...* (1989) and Ramadan (1997) found that root yield responded to N rate up to 90 Kg/fed. Sharif and Eghbal (1994) conducted field trials on

loamy clay soil where 7 Germen sugar beet cultivars were given from zero up to 150 Kg N/ha. They found that sugar yields increased with increasing N rate up to 150 Kg/ha. Total soluble solids and juice purity % decreased with increasing N rates. El-Hennawy *et al.* (1998) reported that increasing N rate up to 120 Kg/fed increased individual root weight by 166 and 181 g in the two growing seasons of study, respectively. Excessive N application lowered beet quality in terms of root sucrose content and recoverable sugar per ton of beet. Recoverable sugar yield followed a production pattern similar to root yield with maximum sugar yield and profits at 90 Kg N/fed. Number of plants at harvest was not significantly affected by N rates. Mahmoud *et al.* (1999) found that application of 100 Kg N/fed produced the heaviest roots, the highest number of roots at harvest, the highest yields of roots, and sugar, while quality traits in terms of sucrose, purity and recoverable sugar percentage were decreased with high N rate. Shalaby *et al.* (2003) and Ramadan (2005) reported that applying 100 Kg N/fed gave the highest chemical constituents of fresh beet root. They added that increasing N rate up to 120 Kg/fed increased root and sugar yields/fed. However, sucrose and purity percentages as well as sucrose loss to molasses were decreased as N rates increased up to 120 Kg/fed. Ismail and Abo El-Ghit (2005) found that application of 155 Kg N/fed significantly increased root fresh weight/plant by 52.57 and 30.03 % and root yield by 12.28 and 10.12 %, while sucrose percentage was reduced by 11.11 and 14.63 % in the first and second seasons, respectively. Masri (2008) in a sandy loam soil reported that application of 120 Kg N/fed was recommended for sucrose content, purity, extractable sucrose and sugar yield.

Time of N application plays a great role in increasing the effectiveness of a given rate of N. Little is know about the response of beet to different time of nitrogen application. In this connection, Carter and Traveller (1981) found that N application until mid – season caused a greater proportion of the photosynthates to be used for the continuity of top growth at the expense of dry matter and sucrose accumulation in the roots. Moreover, lat N application reduced sucrose and increased impurities in the beet roots and reduced extractability of stored sucrose.Abdel-Hafeez *et al.* (1984) found that no significant differences in root and sugar yields from splitting N at thinning (at 4-leaf stage) and or one month or two months after thinning. However, sucrose content and purity decreased with the late application of nitrogen. Top yield increased with the delay of N application. Anderson and Petersson (1988) investigated the value of applying N in split doses to increase sucrose production and decrease top growth and impurities of sugar beet. They added that 30-300 Kg N/ha in doses of 30, 60 and 90 Kg over 16 weeks each year for 3 years on very fine sandy loam soils. They found that delaying N supply by splitting fertilizer application favoured root development and sucrose production but did not affect top growth. Zalat and Saif (1997) applyed N at sowing and at 60, 80,100,120 and 140 days after sowing. They found that the highest root and sugar yields resulted from N applied 80 days after sowing, while sucrose percentage was highest when N was applied at 100 days after sowing. Late N application (140 days after sowing) gave the highest top yield. Abdou (2000) and leilah *et al.* (2005) reported that splitting

N into 4 portions of 45,60,75 and 90 days from planting were associated with the highest values of root length and diameter, number of plants at harvest, root fresh weight as well as root and sugar yields. Early splitting into two equal portions 45 and 60 days from planting recorded the highest sucrose content and total soluble solids. Addling N in four portions gave the highest purity, root yield, top yield and sugar yield.

The purpose of this article was to study the response of sugar beet to nitrogen rates and its time of application in newly reclaimed soil.

MATERIALS AND METHODS

Two field experiments were conducted at Sedment location, Beni-Sweif Governorate during 2007/2008 and 2008/2009 season to find out the most suitable N rate and time of application and their effect on sugar yields and some of its attributes under sprinkling irrigation. Four nitrogen rates; 100,120,140 and 160 Kg N/fed in the form of ammonium nitrate (33% N) were used. Three dates of N time application were included in this experiment. The first date included dividing the nitrogen dose into two equal parts and applied the first half at 4-leaf stage and the second half at 8- leaf stage. The second date included dividing the N rate into three equal parts and applied them ⅓ at 4- leaf stage, ⅓ at 8- leaf stage and ⅓ three weeks latter. The third one included dividing the N rate into four equal parts and added ¼ at 4- leaf stage + ¼ at 8- leaf stage + ¼ three weeks latter + ¼ three weeks after. Preceding crops and soil characteristics of sugar beet experimental fields during 2007/08 and 2008/09 seasons

A split plot design with four replications was used. Nitrogen rates were allocated to the main plots, while application time was distributed at random in the subplots. Sugar beet cultivar " Pleno" was sown on ridges 60 cm apart and 17.5 cm between hills. Each subplot included 5 ridges each is 4 m in length. Therefore each subplot size was 12 m^2. Sugar beet seeds were sown on the second week of October of each year. Phosphorous in the form of super phosphate (15.5%) at rate of 30 Kg P_2O_5 /fed was added before sowing and during land preparation. Potassium in the form of potassium sulfate (48%) was added at the rate of 48 Kg K_2O/fed with the first dose of N. Thinning took place to one plant/hill at 4-leaf stage (4 weeks from planting). Other culture practice procedures were done as recommended.

Sugar beet was topped and harvested by hand on May 15th (210 days from planting). Roots were harvested from each plot. Weight per plot was obtained and used to calculate root on a per-feddan basis. Ten root pulp samples were taken at random from each plot to determine juice quality traits. Total soluble solids (TSS) was determined by using digital refractometer model PR-1,ATAGO, Japan. Sucrose % was determined polarimetrically on lead acetate extract of fresh macerated roots according to Carruthers and Oldfield (1960). Purity was calculated by dividing sucrose by TSS. Extractable sucrose% was calculated using the following equation from Dexter et al.., (1967):

Extractable sucrose % = [sucrose % - 0.3] [1-(1.667($\frac{\text{100-purity}}{\text{purity}}$)]

Sugar yield was calculated according the following equation:
Sugar yield ton fed^{-1} = root yield ton fed^{-1} x Extractable sucrose %

Collected data were subjected to normal statistical analysis as shown by Snedecor and Cochran (1989). Treatment mean comparisons were made using least significant difference(LSD) at 5% level of probability.

Table 1. Preceding crops and soil characteristics of sugar beet experimental fields during 2007/08 and 2008/09 seasons

	2007/ 2008	2008/ 2009
Preceding crop	Maize	Follow
Soil sample date	15 Oct.	15 Oct.
Soil texture	Sandy loam	Sandy loam
pH	8.60	9.00
E.C (m/cm)	2.50	2.80
Na (mq/l)	1.00	1.20
Cl (mq/l)	24.00	26.4
$CaCO_3$ %	28.20	30.00
N (mg kg^{-1})	20.00	18.00
P (mg kg^{-1})	28.00	30.00
K (mg kg^{-1})	168.00	174.00
Fe (mg kg^{-1})	8.60	9.20
Zn (mg kg^{-1})	0.56	0.60
Mn (mg kg^{-1})	4.70	5.00

RESULTS AND DISCUSSION

A-Effect of nitrogen rates:

Data presented in Table 2 show the effect of N rates on yield, yield component and juice quality traits in both seasons of study.

Results revealed that N rates exhibited significant effect on root fresh weight in both seasons. A gradual increase in root weight as N rate increased up to 160 Kg/fed was recorded. The increase amounted to 10.52%, 13.46% and 16.52% in the first season and 6.96%, 16.33% and 24.77% in the second season as N rate increased from 100 to 120, 140 and 160 Kg/fed, respectively. This increase in root weight is mainly due to the role of N in stimulating the meristematic growth activity which contributes to the increase in number of cells in additions to cell enlargement. Similar findings were reported by El-Hennawy *et al.* (1998) and Ismail and Abo El- Ghit (2005).

Number of plants at harvest was significantly affected by N rates in both seasons. Increasing N rate up to 160 Kg/fed increased number of plants at harvest by 4.05 and 2.89 thousand plants/fed as compared to application of 100 kg N/fed in the first and second seasons, respectively. This result is in agreement with that obtained by Mahmoud *et al.* (1999).

Significant differences among N rates in their effect on root yield were recorded in both seasons (table 2). Increasing N rate from 100 to 120 kg/fed, from 120 to 140 kg/fed and from 140 to 160 kg/fed increased root yield by

about 14.53%, 10.81% and 7.20% in the 1st season, corresponding to 16.35%, 7.20% and 11.42% in the 2nd season, respectively. The increase in root yield accompanying high N rate might have been due to the increase in number of harvested root as well as individual root weight as mentioned before. Such results are in accordance with those reported by Halverson and Hartman (1980), Sharif and Eghbal (1994), El-Hennawy *et al.* (1998), Shalaby *et al.* (2003), Ismail and Abo El- Ghit (2005) and Masri (2008).

Table 2. Effect of nitrogen level on sugar beet yield and some of its attributes during 2007/2008 and 2008/2009 seasons.

Nitrogen levels(kg/fed)	Root fresh weight (g)	Number of plants/fed x 10^3	Root yield (ton/fed)	Sucrose %	Purity %	Extractable sucrose %	Sugar yield (ton/fed)
	2007/2008 season						
100	834.44	23.89	20.03	19.24	82.56	12.29	2.51
120	922.22	24.83	22.94	20.57	84.26	13.97	3.24
140	946.67	26.78	25.42	19.20	82.34	12.16	3.21
160	972.22	27.94	27.25	18.63	81.24	11.28	3.26
LSD at 5%	34.69	0.68	0.57	0.33	0.71	0.50	0.13
	2008/2009 season						
100	830.00	25.72	21.41	19.42	83.01	12.61	2.69
120	887.78	27.89	24.91	20.62	84.53	14.13	3.55
140	965.56	27.44	26.70	19.16	83.31	12.57	3.42
160	1035.56	28.61	29.75	18.73	81.79	11.60	3.59
LSD at 5%	48.24	0.55	1.45	0.24	1.06	0.57	0.21

Root quality traits, in terms of sucrose, purity and extractable sucrose percentage were significantly affected by varying N rates in both seasons (table 2). Increasing N rate from 100 to 120 kg/fed significantly increased sucrose by 1.33 %, purity by 1.70 % and extractable sucrose by 1.68 % in the first season, corresponding to 1.20 %, 1.52 % and 1.52% in the second season, respectively, thereafter further increase in N rate lowered beet quality. The lowest values of sucrose, purity and extractable sucrose resulted from 160 kg N/fed. The depressive effect of higher excessive N on beet quality coincides whit those reported by Carter and Traveller (1981), Kamel *et al.* (1989), Sharif and Eghbal (1994), El-Hennawy *et al.* (1998), Shalaby et al. (2003) and Ramadan (2005).

Results in table (2) cleared that sugar yield was significantly increased by increasing N rate from 100 to 120 Kg/fed. These results were true in the two growing seasons. Such increase amounted to 29.08 % in the first season and 31.97 % in the second one. Additional increasing in nitrogen rate beyond 120 kg N/fed had no significant effect on sugar yield in both seasons, since 120 kg N/fed was at bar at 160 kg N/fed. It is worthy to mention that the reduction in quality traits (sucrose, purity and recoverable sucrose) accompanying higher N rates was compensated for higher root yield. Similar results were reported by Sharif and Eghbal (1994), El-Hennawy *et al.* (1998), Mahmoud (1999), Ramadan (2005) and Masri (2008).

B- Effect of time of N application:

Data presented in the table (3) revealed that root fresh weight was significantly affected by time of N application in both seasons. Split application of N in four equal doses produced the heaviest roots with an average of 948.34 and 1020.83 gm in the first and second season, respectively, while the lowest values of root fresh weight resulted from N applied in two equal doses. This result is in agreement with those obtained by Abdou (2000) and leilah *et al.* (2005), who reported that late N application increased root weight of sugar beet.

Number of plants at harvest was significantly increased as N application was delayed. Splitting N into 4 equal doses (at 4,8 leaf stage and 3 and 6 weeks later) resulted in the highest number of roots at harvest which exceeded that of N applied into two equal doses by 18.05 % and 13.16 % in the first and second seasons, respectively. Similar results were reported by Abdou (2000) and leilah *et al.* (2005).

Table 3. Effect of application time of nitrogen on sugar beet yield and some of its attributes during 2007/2008 and 2008/2009 seasons.

Time of application	Root fresh weight (g)	Number of plants/fed x 10^3	Root yield (ton/fed)	Sucrose %	Purity %	Extractable sucrose %	Sugar yield (ton/fed)
	2007/2008 season						
2	879.17	23.54	20.78	20.20	84.52	13.84	2.95
3	929.17	26.25	24.43	19.49	82.65	12.49	3.16
4	948.33	27.79	26.52	18.54	80.63	10.94	3.06
LSD at 5%	28.70	0.81	0.94	0.18	0.46	0.24	0.13
	2008/2009 season						
2	845.00	25.92	21.96	20.33	85.00	14.15	3.20
3	923.33	27.00	25.02	19.52	83.12	12.72	3.26
4	1020.83	29.33	30.09	18.60	81.36	11.32	3.48
LSD at 5%	42.69	0.67	1.24	0.17	0.63	0.37	0.24

Significant differences among times of N application in root yield/fed were reported in both seasons (Table 3). The highest root yield (26.52 and 30.09 ton/fed resulted from splitting N rate into 4 equal doses (at 4 and 8 leaf stage + 3 and 6 weeks later) followed by splitting N rate into 3 equal doses (24.43 and 25.02 ton/fed) and then splitting N rate into two equal doses (20.78 and 21.96 ton/fed) in the first and second seasons, respectively. It is worth mentioning that the increase in root yield/fed with the delay in N application might have resulted from the increase in number of roots at harvest as well as to the increase in individual root weight accompanying the delay of N application in sandy soil. The favorable impact of delayed N application on root production of sugar beet was also reported by Carter and Traveller (1981), Zalat and liala-Saif (1997), Abdou (2000) and leilah *et al.* (2005).

Timing of N application exhibited significant effect on juice quality traits in both growing seasons (table 3). Early application of N improved beet quality. The highest sucrose, purity and Extractable sucrose percentage resulted from application of ½ the dose at 4-leaf sage and the other ½ dose at 8-leaf stage. Delaying N application lowered root quality traits. The lowest sucrose (18.54 and 18.60 %) purity (80.63 and 81.36 %) and Extractable sucrose (10.94 and 11.32 %) resulted from splitting N into 4 equal doses in the first and second seasons, respectively. The depressive effect of late N application on beet quality was reported by Abdel-Hafeez *et al.* (1984), Anderson and Petersson (1988), Abdou (2000) and leilah *et al.* (2005).

Sugars yield/fed significantly responded to time of N application in both seasons. Early application of N at 4- and 8- leaf stages produced the lowest sugar yield per fed (2.95 and 3.20 ton/fed). Sugar yield increased with splitting N into three equal doses (3.16 and 3.26 ton/fed) and with splitting it into four equal doses (3.06 and 3.48 ton/fed), in the first and second seasons, respectively. It is worth to mention that the reduction in juice quality traits (sucrose, purity and extractable sucrose) accompanying late N application was compensated for the increase in root yield/fed and finally sugar yield was increased. Similar results were obtained by Carter and Traveler (1981), Anderson and petersson (1988), and leilah *et al.* (2005).

C- Effect of the interaction between rates and time of N application:

Data presented in Table 4 indicated that root fresh weight was significantly affected by the interaction between N rate and time of its application in both seasons. The heaviest roots; 1003.33 and 1150.00 gm resulted from applying 160 and 140 Kg N splitted into 4 equal doses in the 1st and 2nd seasons, respectively. N-rate x time of application interaction exhibited significant effect on number of plans/fed at harvest. Applying 160 Kg N/fed splitted in 4 equal doses produced the highest number of plants at harvest being 31.00 and 30.67 thousand plants in the first and second seasons, respectively. The highest root yield/fed resulted from applying 140 and/or 160 Kg N splitted into 4 equal doses. Differences between 140 and 160 Kg N being significant only in the 1st season (table 4).Data averaged over seasons (Fig. 1) indicated that splitting 160 kg N/fed into 4 equal doses resulted in the highest root yield/fed.

N-rate x time of N application had a significant effect on sucrose content. The highest sucrose content (21.50 and 21.57 %) resulted from 120 kg N splitted into two equal doses at 4-and 8-leaf stage (Table 4). Purity and extractable sucrose percentages were not significantly affected by the interaction between N rate and time of application. Results also revealed that splitting 120 kg N/fed into 4 equal doses was recommended for high sugar yield /fed in both seasons. Data averaged over seasons revealed that Application of 120 kg N/fed in two equal doses gave the highest values of sucrose percentage (Fig. 2) and extractable sucrose percentage (Fig. 3), while application the same rate of nitrogen at 4 equal doses gave the highest value of sugar yield/fed (Fig. 4).

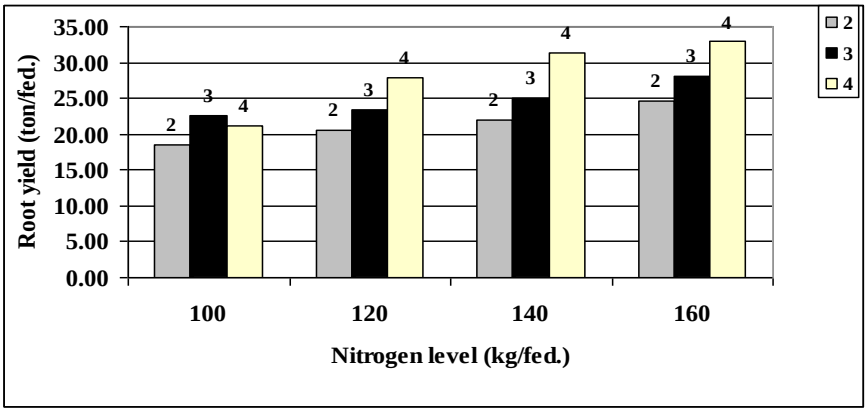
Table 4. Interaction effect between nitrogen levels and its time of application on sugar beet yield and some of its components in 2007/2008 and 2008/2009 seasons.

Nitrogen levels (kg/fed)	Time of application	Root fresh weight (g)		Number of plants/fed x 10^3		Root yield (ton/fed)	
		2007/08	2008/09	2007/08	2008/09	2007/08	2008/09
100	2	803.33	790.00	21.50	24.67	17.33	19.53
	3	880.00	866.67	25.33	26.33	22.33	22.88
	4	820.00	833.33	24.83	26.17	20.43	21.81
120	2	876.67	816.67	22.50	26.17	19.72	21.33
	3	913.33	880.00	25.67	26.33	23.45	23.17
	4	976.67	966.67	26.33	31.17	25.67	30.23
140	2	906.67	820.00	24.50	26.33	22.19	21.69
	3	940.00	926.67	26.83	26.67	25.24	24.74
	4	993.33	1150.00	29.00	29.33	28.81	33.67
160	2	930.00	953.33	25.67	26.50	23.89	25.29
	3	983.33	1020.00	27.17	28.67	26.70	29.29
	4	1003.33	1133.33	31.00	30.67	31.17	34.67
LSD at 5%		57.41	85.38	1.62	1.34	1.88	2.48

Table 4. Continued.

Nitrogen level (kg/fed)	Time of application	Sucrose %		Purity %		Extractable sucrose %		Sugar yield (ton/fed)	
		2007/08	2008/09	2007/08	2008/09	2007/08	2008/09	2007/08	2008/09
100	2	20.00	20.43	84.03	85.14	13.46	14.27	2.33	2.79
	3	19.53	19.43	82.77	82.70	12.56	12.46	2.87	2.85
	4	18.20	18.40	80.89	81.18	10.85	11.10	2.32	2.42
120	2	21.50	21.57	86.00	86.27	15.45	15.62	3.05	3.41
	3	20.70	20.63	84.37	84.56	14.10	14.15	3.38	3.35
	4	19.50	19.67	82.41	82.75	12.36	12.63	3.29	3.89
140	2	20.03	19.90	84.29	85.30	13.60	13.96	3.15	3.17
	3	19.10	19.23	82.45	83.62	12.13	12.75	3.18	3.28
	4	18.47	18.33	80.29	81.01	10.73	10.98	3.31	3.81
160	2	19.27	19.43	83.77	83.29	12.84	12.73	3.26	3.41
	3	18.63	18.77	81.01	81.59	11.17	11.52	3.20	3.54
	4	18.00	18.00	78.95	80.49	9.83	10.54	3.31	3.81
LSD at 5%		0.35	0.35	NS	NS	NS	NS	0.26	0.40

NS = Non significant



2 = Splitting N rate into 2 equal doses, 3 = Splitting N rate into 3 equal doses and 4 = Splitting N rate into 4 equal doses.

Fig. 1. Root yield of sugar beet as affected by the interaction between nitrogen levels and its time of application (combined over years).

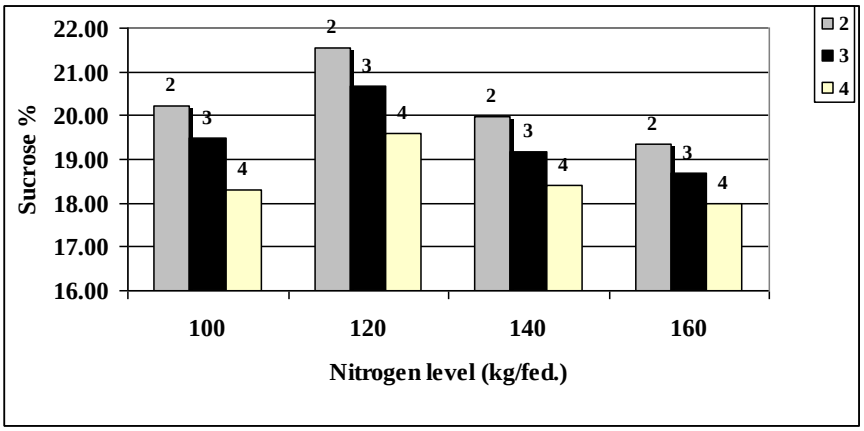


Fig. 2. Sucrose content of sugar beet as affected by the interaction between nitrogen levels and its time of application (combined over years).

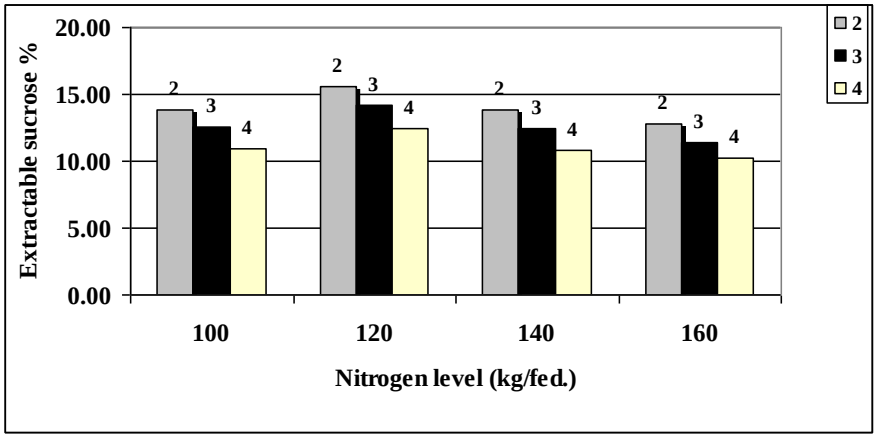


Fig. 3. Extractable sucrose of sugar beet as affected by the interaction between nitrogen levels and its time of application (combined over years).

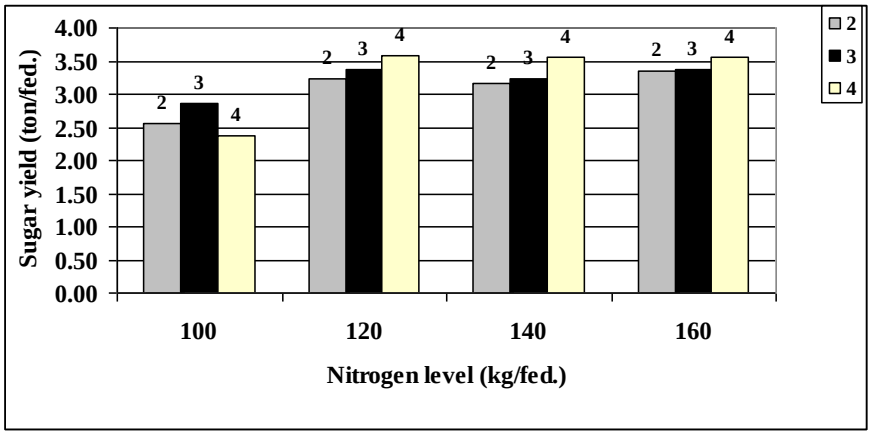


Fig. 4. Sugar beet yield as affected by the interaction between nitrogen level and its time of application (combined over years).

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تأثير معدل وميعاد اضافة النيتروجين على انتاجية بنجر السكر تحت نظام الرى بالرش فى الأراضى المستصلحة حديثا

السيد عبد العزيز محمود و محمد ابراهيم مصرى
قسم المحاصيل- كلية الزراعة- جامعة القاهرة

نفذت تجربتان حقليتان فى أرض الخريجين بمنطقة سدمنت الجبل بمحافظة بنى سويف خلال موسمى ٢٠٠٨/٢٠٠٧ و ٢٠٠٩/٢٠٠٨ وذلك لدراسة استجابة المحصول وبعض مكوناته فى بنجر السكروذلك تحت نظام الرى بالرش لمعدلات مختلفة من السماد النيتروجينى (١٠٠، ١٢٠ ، ١٤٠ ، ١٦٠ كجم أزوت/فدان) أضيفت اما على دفعتين متساويتين (فى عمر ٤ أو ٨ ورقات على النبات) أو ثلاث دفعات متساوية (٣/١ فى عمر ٤ ورقات + ٣/١ فى عمر ٨ ورقات + ٣/١ بعد ٣ أسابيع من الدفعة السابقة) أو أربع دفعات متساوية (٤/١ فى عمر ٤ ورقات + ٤/١ فى عمر ٨ ورقات + ٤/١ بعد ٣ أسابيع من الدفعة السابقة + ٤/١ بعد ٣ أسابيع من الدفعة الأخيرة). و استخدام تصميم القطع المنشقة مرة واحدة فى أربع مكررات بحيث خصصت القطع الرئيسية لمعدلات النيتروجين، بينما خصصت القطع المنشقة لمواعيد الاضافة. وقد أظهرت نتائج الدراسة ما يلى:-

أدى زيادة معدل التسميد الأزوتى من١٠٠ كجم/فدان الى ١٦٠كجم/فدان الى حدوث زيادة معنوية فى كل من متوسط وزن الجذر(١٦,٥١% و٢٤,٧٧%) ، عدد النباتات عند الحصاد (٤,٠٥ ، ٢,٨٩ الف نبات/فدان) ، محصول الجذور(٧,٢٢ و ٨,٣٤ طن/فدان) وذلك فى الموسمين الأول والثانى على التوالى. و أدى التسميد الأزوتى بمعدلات أعلى من ١٢٠ كجم/فدان الى حدوث انخفاض ملحوظ فى صفات الجودة متمثلة فى نسبة السكروز ، النقاوة، نسبة السكروز المستخلص. و زاد محصول السكر للفدان بزيادة معدل التسميد الأزوتى من ١٠٠ كجم/فدان الى ١٢٠ كجم/فدان، حيث كانت هذة الزيادة حوالى ٢٩,٠٨% فى الموسم الأول بينما كانت حوالى ٣١,٩٧% فى الموسم الثانى . ولم يكن لزيادة التسميد الأزوتى عن ١٢٠ كجم/فدان أى تأثيرا معنويا على محصول السكر/فدان.

أدى اضافة السماد الأزوتى على أربع دفعات متساوية الى حدوث زيادة معنوية فى كل من متوسط وزن الجذر، عدد النباتات عند الحصاد ، محصول الجذور للفدان ، بينما أدت الاضافة المبكرة للتسميد (اضافة السماد على دفعتين متساويتين) الى تحسين صفات الجودة متمثلة فى نسبة السكروز ، النقاوة ، نسبة السكروز المستخلصة.

أدى التسميد بمعدل ١٦٠ كجم وحدة أزوت/ فدان على أربع دفعات متساوية الى انتاج أعلى محصول من الجذور للفدان ، بينما نتج أعلى محصول من السكر للفدان من اضافة ١٢٠ كجم وحدة أزوت/فدان على أربع دفعات متساوية.