EFFECT OF NITROGEN FERTILIZATION ON YIELD AND QUALITY OF SOME SUGAR BEET VARIETIES.

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Abstract

Two field trials were carried out at the Agricultural Experiment Research Station, Faculty of Agriculture, Cairo University, during 2001 / 2002 and 2002 / 2003 seasons .The aim of this study was to investigate the response of four sugar beet varieties (Top, Lola, Pleno and Farida), to different levels of nitrogen fertilization (0, 31, 62, 93, and 124 Kg N /fed) .

Results showed that varieties differed in its juice qualities and yield components. There is superiority of Lola variety over other varieties in sucrose, purity , recoverable sugar percentages and root weight as well as root and sugar yields in both seasons, while Farida variety gave the highest number of roots and top yields at harvest .

Increasing the rate of nitrogen up to 124 Kg /fed decreased sucrose, purity, corrected sugar percentages and quality traits but increased impurities and sucrose loss to molasses while gave the highest mean root weight, top and root yields (ton / fed). Each nitrogen increment up to 93 Kg /fed was accompanied by an increase in sugar yield (ton/fed), thereafter sugar yield was unaffected by further application of nitrogen.

Varieties X nitrogen rates had a significant effect on all traits except sucrose % and amino-N in both seasons. The Pleno variety was superior in quality (beet quality %, purity and corrected sugar percentages) in both seasons. The highest mean root weight and root yield were obtained from the 124 Kg N/fed and Lola variety in both seasons, while Farida variety and 124 Kg N/fed. gave the highest top yield in the 1st season.).

The highest sugar yield (ton/fed.) resulted from Lola variety (4.29ton/fed. In the 1st season) and at 124 Kg N/fed. In the 2nd season Lola variety gave the highest sugar yield (4.39 ton /fed. at 93 Kg N/fed.).

INTRODUCTION

Several workers elucidated the importance of varieties and nitrogen rate on sugar beet plant *(Beta vulgaris L.*), Nassar (1992) , Sharif and Eghbal (1994),and El Hinnawy *et al* (2002) reported that varieties varied in growth, sucrose %, purity, top, root and sugar yields. Also varieties differ in response to soil applied nitrogen (Hanna, *et al.,* 1988).

High level of nitrogen may produce maximum root yield , while reduce root quality and sugar yield (Sharif and Eghbal, 1994;El Hinnawy, et al., 2002). (Besheit , *et al.* 1995) applied 32, 46, 69, 92, 115 and 138 Kg N /fed and found an increase parallel to added nitrogen level, but root and top yields ,sucrose and purity percentages decreased. He also found that Increasing nitrogen level up to 90 Kg N/fed markedly increased top, root and recoverable sugar yields. However increasing the rate of N a reduced recoverable sugar yield and quality. Sarhan (1998)reported that nitrogen fertilizer up to 100 Kg N/fed. increased Significantly root weight, root yield and markedly decreased sucrose and purity percentages. Nemeat Alla *et al* (2002) reported that increasing nitrogen rate up to 90 Kg N/fed significantly increased top, root and sugar yields, while total soluble solids (TSS), sucrose and purity percentages decreased .In Egypt Recommended nitrogen rate differed from country to another,(Mostafa Zeinab,R *et al* 2000) .

The objectives of this study were to explain the performance of four recently introduced sugar beet varieties and their response to various rates of nitrogen fertilizer.

MATERIALS AND METHODS

Two field experiments were conducted at the Agricultural Experiment Station, Faculty of Agriculture, Cairo University, Giza, Egypt, during 2001/2002 and 2002/2003 seasons .The physical and chemical analysis of the soil are shown in Table (1). Randomized Complete Block Design (RCBD) in split plot arrangement was used in both seasons. The main plots were sugar beet varieties (Top, Lola, Pleno and Farida), Nitrogen rates were (0, 31, 62, 93, and 124 Kg N / fed.) in form of ammonium nitrate (31 % N) were arranged in the sub plots (Table 2). Nitrogen rates were divided and applied twice after 30 and 60 days from sowing. The area of sub plots was 12 m^2. Each sub plot consisted of six ridges, 4 m long and 50 cm apart. Sowing was done in one side with hills spaced by 20 cm. Sowing dates were 25th and 27th

October in both seasons, respectively. A fixed rate of phosphorus (30 Kg P2O5 / fed.) and potassium (48 Kg K2O) in the form of superphosphate and potassium sulphate, respectively, was incorporated in the soil during seed bed preparation.

Plants were harvested after 7 months from sowing. A sample of ten roots (after topping)were taken for determining the following quality traits:

1-Total soluble solids (TSS)was determined using hand refractometer.

2-Sucrose percentage was determined using Sacharimeter on a lead acetate basic according to Carruthers and Oldfield (1960).

3-Purity % = sucrose % /TSS x 100 according to Carruthers and Oldfield (1960).

4-Corrected sugar % was calculated using the following equation from Reinefeld *et al* (1974). Corrected sugar % (% beet) = Pol - [0.434 (K + Na) + 0.094 amino-N + 0.29].

Where pol = sucrose %, K and Na = potassium and sodium in milliequivalent (100 g beet).

5-Sodium and potassium were detrmined according to A.O.A.C. (1984).

6-αamino- nitrogen (milliequivalent/ 100 g beet) according to A.O.A.C. (1984).

7- Sucrose loss to molasses% = 0.343 (Na + K) + 0.094 Amino-N- 0.31 according to Reinefeld *et al* (1974).

8- Beet quality % (Quality parameter) = corrected sugar / pol x according to the procedure of Delta Sugar Company.

In addition to the above mentioned traits the following ones were determined on the whole plot basis.

1-Root weight (g).

2-Top yield (ton/fed).

3-Root yield (ton/fed).

4-Sugar yield (ton/fed.) = Corrected sugar % x root yield (ton/fed)/ 100

Data of each season were subjected to regular analysis of variance of RCBD in split plot using the MSTATC package. The differences among the means were tested by least significant difference (LSD) at 5% level.

Table 1 .Physical and chemical analysis of the experimental soil, in 2001 / 2002 and 2002 / 2003 seasons.

Fraction	Seasons	
	2001/2002	2002/2003
A- physical analysis		
Sand %	23.6	24.8
Silt %	26.6	27.8
Clay %	49.8	47.4
Soil texture	clay texture	Clay texture
B- Chemical analysis		
Total nitrogen	0.9	0.10
Available phosphorus	14.8 ppm	15.1ppm
Avalabble potassium	335 ppm	360 ppm
PH	7.3	7.1
Organic matter	1.6	1.7

Table 2 . Varieties and their country of origin.

NO	Variety	Country of origin
1	Top	Germany
2	lola	Germany
3	Pleno	Holland
4	Farida	Holland

RESULTS AND DISCUSSION

1-Performance of varieties

Varieties differed significantly in sucrose, purity and corrected sugar as well as beet quality percentages in the first season,(Table 3). However, such significant differences were lacked in the second season for purity and beet quality percentages.

Lola variety recorded significantly higher percentages for sucrose, purity and corrected sugar over the other varieties in both seasons. On the other hand , the variety Farida showed the least performance for the four mentioned traits. Regarding the beet quality % Pleno variety detected the highest values in both seasons, irrespective of lacing insignificant in second one.

Table 3. Mean performance of varieties for Sucrose %, purity, corrected sugar and beet quality percentages in both seasons.

Varieties	2001/ 2002				2002/2003			
	Sucrose %	Purity %	Corr. Sugar %	beet Quality %	Sucrose %	Purity %	Corr. Sugar %	Beet Quality %
Top	16.5	81.7	13.8	83.5	16.3	78.8	13.6	83.5
Lola	17.5	86.4	14.7	83.9	17.2	82.4	14.2	82.7
Pleno	16.3	81.4	14.0	85.8	16.0	78.9	13.5	84.2
Farida	15.8	78.5	13.2	83.4	15.7	77.5	13.1	83.4
LSD 0.05	0.4	2.6	0.5	0.8	0.4	Ns	0.5	Ns

It is worth to mention that the highest impurity values in terms of Na, K, and α amino-N as well as sucrose loss to molasses were recorded by Lola variety in both seasons (Table 4).On the other hand, Pleno variety exhibited significantly lowest impurity measures in both seasons in addition to the sucrose loss to molasses. These results are in harmony with those obtained by Ramadan and Hassanin (1999).

It is worth to monition that the superiority of Pleno variety in least sucrose loss to molasses might have resulted from its lowest impurities ; Na, K and amino-N which was reflected in high beet quality percentage. These results are in line with those stated by Ramadan and Hassanin (1999).

Table 4. Impurities and sucrose loss to molasses as affected by varieties in both seasons.

Varieties	2001/2002				2002/ 2003			
	Meq/100g				Meq /100g			
	Na	K	Amino-N	Sucrose Loss to Molasses	Na	K	Amino-N	Sucrose Loss to Molasses
Top	2.18	4.46	1.65	2.13	2.22	4.23	1.83	2.09
Lola	2.20	4.66	1.84	2.22	2.25	5.01	1.95	2.38
Pleno	1.69	3.86	1.30	1.73	2.10	3.99	1.53	1.94
Farida	2.02	4.28	1.63	2.01	2.10	4.13	1.73	2.00
LSD 0.05	0.23	0.42	0.120	0.11	0.10	Ns	0.13	0.25

Varieties exhibited significant differences in root weight in both seasons Table 5. Lola variety gave the highest mean root weight with an average of 749 and 771 g in 1st and 2nd seasons, respectively. Pleno variety gave the lowest value of root weight (563 and 630g) in both seasons, respectively. Lola variety possessed superiority in root

yield and sucrose % corresponding to lower purity attributed. The variation among varieties in root size was reported by Nassar (1992).

Data in Table (5) indicated that varieties had a significant effect on top yield at harvest in both seasons, respectively. The highest top yield at harvest were obtained from Farida variety (11.3, 10.7 tons/fed.) in 1st and 2nd seasons, respectively while the lowest top yield (tons / fed.) resulted from Pleno variety in both seasons.

Both root and sugar yields (tons/ fed.)differ significantly among varieties (Table 5).The highest values of root and sugar yields were produced from Lola variety (26.3, 27.0 and 3.80 and 3.79 tons /fed.)in both seasons, respectively. The superiority of Lola variety over other varieties in sugar yield may be due to the increase in purity, corrected sugar percentages and root yield . These results are in harmony with those of Sharif and Eghbal (1994),El Hinnawy et al (2002) and Mahmoud *et al* (2002), who reported that varieties differ in quality , root and sugar yields .

Table 5. Yield and yield components as affected by varieties in both seasons.

Varieties	2001 /2002				2002 /2003			
	Root Weight (g)	Yield (ton/fed.)			Root Weight (g)	Yield (ton/fed.)		
		Top	Root	Sugar		Top	Root	Sugar
Top	653	9.5	23.4	3.13	703	8.9	25.1	3.38
Lola	749	10.7	26.3	3.80	771	9.8	27.0	3.79
Pleno	563	9.3	20.4	2.77	630	8.6	22.4	2.98
Farida	583	11.3	22.0	2.81	653	10.7	24.3	3.13
LSD 0.05	34	0.3	0.9	0.19	19	0.45	0.6	0.17

2- Effects of nitrogen fertilization :

Sucrose, purity and corrected sugar percentages significantly decreased by increasing nitrogen rates (Table 6). Nitrogen rate of 124 Kg N / fed. lowered this traits by 1.3, 4.7, 1.7 % and 1.8, 6.8, 2.3 % in both seasons, respectively compared with the control (0 Kg N /fed.). The decrease in corrected sugar % accompanying higher nitrogen rate may explain the reduction in sucrose and purity as well as beet quality percentages and increase of impurities in terms of Na, K, and amino-N contents. Similar results were obtained by Sarhan (1998).

Nitrogen rates significantly affected the beet quality % in both seasons (Table 6). Beet quality % was gradually decreased as the rate of applied nitrogen increased. The decrease of beet quality % accompanying the increase N rate may be attributed the increase in impurities (Na, K, and amino-N)and corrected sugar %.

Increasing nitrogen rate up to 124 Kg /fed. significantly increased impurities in terms of Na, K, and amino-N in the 1st and 2nd seasons (Table 7). The increase in impurities accompanying high nitrogen rate may explain the reduction in corrected sugar. Similar results are in harmony with those obtained by El Hinnawy et al (2002).

Table 6. Sucrose %, purity, corrected sugar and beet quality % as affected by nitrogen rates in both seasons.

N rate Kg/fed	2001/2002				2002/2003			
	Sucrose %	Purity %	Corr. Sugar %	beet Quality %	Sucrose %	Purity %	Corr. Sugar %	beet Quality %
0	17.0	83.9	14.6	85.8	17.1	82.5	14.7	85.8
31	16.9	83.5	14.4	85.3	16.7	80.8	14.1	84.7
62	16.8	83.1	14.2	84.7	16.5	80.1	13.8	83.9
93	16.1	80.1	13.3	82.8	15.9	77.9	13.0	82.2
124	15.7	79.2	12.9	82.0	15.3	75.7	12.4	80.5
LSD0.05	0.3	1.6	0.3	0.5	0.2	0.9	0.2	0.7

Sucrose loss to molasses was significantly affected by nitrogen rate in both seasons (Table 7). Increasing nitrogen rate up to 124 Kg / fed. increased sucrose loss to molasses from 1.82 and 1.84 to 2.25 and 2.40 meq in both seasons, respectively . This increase might be due to the increase of impurities (Na, K, and α amino-N) with increasing N rate . Similar results were reported by El Hinnawy *et al* (2002).

Table .7 Impurities and sucrose loss to molasses as affected by nitrogen rates in both seasons.

N rates Kg / fed	2001/2002				2002/2003			
	Meq/100g			Sucrose Loss to Molasses	Meq/ 100g			Sucrose Loss to Molasses
	Na	K	Amino-N		Na	K	Amino-N	
0	1.81	3.99	1.42	1.82	2.01	3.79	1.59	1.84
31	1.92	4.07	1.51	1.89	2.04	4.12	1.66	1.97
62	2.03	4.17	1.55	1.97	2.15	4.22	1.78	2.05
93	2.12	4.62	1.72	2.17	2.30	4.58	1.84	2.23
124	2.21	4.72	1.84	2.25	2.34	4.99	1.94	2.40
LSD 0.05	0.09	0.17	0.09	0.07	0.06	0.31	0.06	0.11

Data in Table(8) indicated that root weight at harvest was significantly affected by N rate. Mean root weight was markedly increased with the increase of nitrogen rate. It is worth to mention that the increase of root weight accompanying nitrogen application was mainly due to its effect on growth of seedlings, which was reflected in producing more vigorous plants. Similar results findings were stated by Ramadan and Hassanin (1999)and El Hinnawy *et al* (2002).

Nitrogen application outyielded significantly the unfertilized control in top yield. Increasing rate up to 124 kg N/fed. substantially improved top yield by 7.1 and 6.1 ton /fed in both seasons, respectively. The present results are in harmony with those obtained by El Hinnawy et al (2002) and Sarhan (1998).

Increasing nitrogen rate up to 124 Kg /fed. Significantly increased root yield by 11.4 and 15.3 tons/fed. In both seasons, respectively (Table 8), reflecting the favorable effect of nitrogen on increasing individual root weight as mentioned befour. The results also clearly showed that sugar yield followed aproduction pattern similar to root yield with maximum sugar yield and profits at 93 Kg N/fed. In the 1st and 2nd seasons, whichis less than that required for maximum root yield. It is worthy to mention that the increase in root yield accompanying 124 Kg N/fed. rate could not compensate for the reduction beet quality % due to lower sucrose % and high Na, and finally sugar production per unit area did not increased. Resuled the current and previous studies (Ramadan and Hassanin, 1999 And El-Shahawy *et al*, 2002)

Table 8. Yield and yield components as affected by nitrogen rates in both seasons.

N rate Kg / Fed	2001/ /2002				2002 /2003			
	Root weight (g)	Yield (tons/fed.)			Root Weight (g)	Yield (tons/fed.)		
		Top	Root	Sugar		Top	Root	Sugar
0	400	6.5	15.9	2.05	434	6.1	14.7	2.15
31	599	8.9	21.1	3.04	663	9.0	23.3	3.30
62	682	10.5	24.2	3.45	726	9.5	26.3	3.64
93	735	11.4	26.3	3.52	799	10.7	29.1	3.80
124	771	13.6	27.3	3.51	823	12.2	30.0	3.72
LSD0.05	26	0.3	0.9	0.15	20	0.4	0.6	0.09

3- Interaction effect :

The interaction between Varieties x nitrogen rates were significantly detected for some quality traits in Table (9) . Sodium content was highest with the variety Top and 124 Kg N/fed., while the lowest Na (1.59 meq) and K (3.54 meq) resulted from Pleno and with zero nitrogen rate.

The highest purity, corrected sugar and beet quality percentages resulted from Farida variety and zero Kg N/fed. ,while the lowest values of purity, corrected sugar and beet quality percentages were resulted from Farida variety and applying 124 Kg N/fed.

Root weight and root yield (tons/fed) were significantly affected by the interaction between varieties and nitrogen rate Table (10).The heaviest roots (899 and 933 g) and highest root yield (30.9 and 33.3 tons/fed.) resulted from Lola variety and with 124 Kg N /fed. The lowest root weight resulted from Pleno variety (379 g) and with zero nitrogen in the 1st season, while Farida variety gave the lowest root weight (443 g in the 2nd season) without nitrogen fertilization. The highest top yield (15.2 ton/fed.) was obtained from Farida variety and 124 Kg N/fed.in the 1st season (Table 10).

Root yield was highest (30.9 and 33.3 ton/fed.)with Lola variety fertilized by 124 Kg N/fed. In both seasons, respectively, while the lowest root yield resulted from Pleno variety and zero nitrogen rate in the two seasons (Table 10 and Fig 1).

The interaction between varieties and nitrogen rate had a significant effect on sugar yield in both seasons (Table 10 and Fig2).The highest sugar yield (ton/fed.) resulted from Lola variety (4.29ton/fed. In the 1st season)and with 124 Kg N/fed. while in the 2nd season Lola variety gave the highest sugar yield (4.39 ton /fed.) with

93 Kg N/fed. Thse results are in harmony with Sharif and Eghbal (1994)who , reported that root and sugar yields were significantly affected by interaction between varieties and nitrogen rate.

In general, it can be concluded that the highest root and sugar yields could be obtained from Lola variety and applying 93 – 124 Kg N/fed..

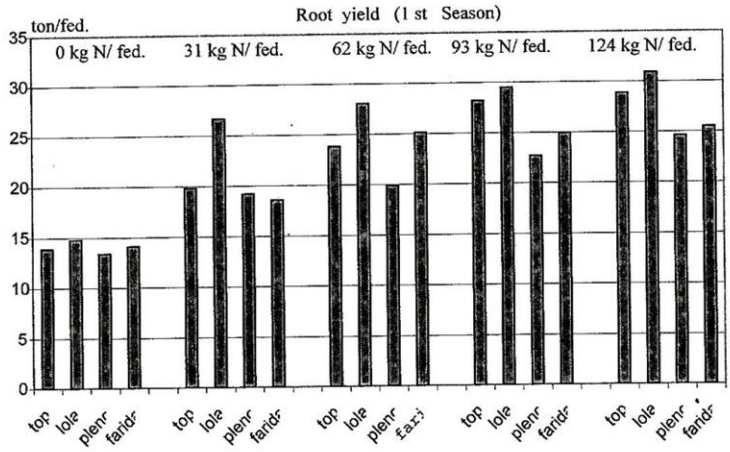
Table 9. Some quality traits as affected by varieties and nitrogen rate interaction.

Treatments		Na Meq.	K Meq.	Purity %	Corret. Sugar %	beet quality %	Sucrose Loss to molass.
		1st	2nd				
Top	0	1.77	3.71	80.4	14.4	85.7	1.82
	31	1.98	4.24	79.9	14.0	84.4	2.00
	62	2.34	4.08	80.7	14.1	84.4	2.02
	93	2.40	4.24	78.2	13.3	82.9	2.16
	124	2.43	4.86	74.9	12.2	80.2	2.45
Lola	0	2.05	4.35	82.8	14.9	84.8	2.07
	31	2.08	4.47	83.5	14.8	84.5	2.13
	62	2.15	4.73	83.1	14.4	83.3	2.30
	93	2.31	5.52	82.1	13.7	81.1	2.60
	124	2.39	6.00	80.7	13.1	79.6	2.78
Pleno	0	1.59	3.54	83.0	14.7	86.3	1.74
	31	1.64	4.38	80.3	13.7	83.8	2.05
	62	1.67	4.08	79.3	13.6	84.1	1.97
	93	1.70	3.96	77.3	13.1	83.8	1.94
	124	1.80	4.02	74.5	12.5	82.9	1.98
Farida	0	1.85	3.57	83.9	14.9	86.3	1.75
	31	1.99	3.93	79.7	14.0	85.9	1.70
	62	1.97	4.00	77.2	13.2	84.0	1.92
	93	1.96	4.60	74.0	12.1	81.1	2.22
	124	2.30	5.07	72.5	11.6	79.4	2.40
LSD	0.05	0.18	0.62	1.8	0.4	1.3	0.21

Table 10. Root weight, root, top and sugar yield as affected by varieties and nitrogen rate interaction.

Treatments		Root Weight (g)		Root		Top	Sugar	
				Yield (tons/fed.)				
		1st	2nd	1st	2nd	1st	1st	2nd
Top	0	402	487	13.9	14.7	6.0	2.00	2.11
	31	576	626	19.8	22.0	8.1	2.81	3.09
	62	677	737	23.8	27.0	9.8	3.38	3.79
	93	793	850	28.2	30.8	10.9	3.78	4.09
	124	818	860	28.9	31.5	12.9	3.69	3.85
Lola	0	413	522	14.8	15.5	7.1	2.25	2.30
	31	775	793	26.7	26.5	10.2	3.98	3.93
	62	810	826	28.1	29.0	10.8	4.22	4.17
	93	809	914	29.5	32.0	11.8	4.21	4.39
	124	899	933	30.9	33.3	13.5	4.29	4.35
Pleno	0	379	457	13.4	14.0	6.1	1.96	2.05
	31	555	619	19.2	21.8	8.0	2.78	2.97
	62	560	645	19.9	23.0	9.5	2.79	3.11
	93	634	692	22.7	25.3	10.0	3.12	3.31
	124	687	764	24.6	27.8	12.8	3.21	3.48
Farida	0	407	443	14.1	14.5	7.0	2.01	2.13
	31	791	615	18.6	23.0	9.3	2.58	3.21
	62	642	698	25.1	26.3	12.0	3.41	3.47
	93	677	742	24.9	28.4	13.0	2.96	3.43
	124	699	782	25.5	29.3	15.2	3.11	3.40
LSD 0.05	5	52	40	1.7	1.2	0.6	0.30	0.18

Fig 1. Root yield as effected by varieties and nitrogen fertilizer



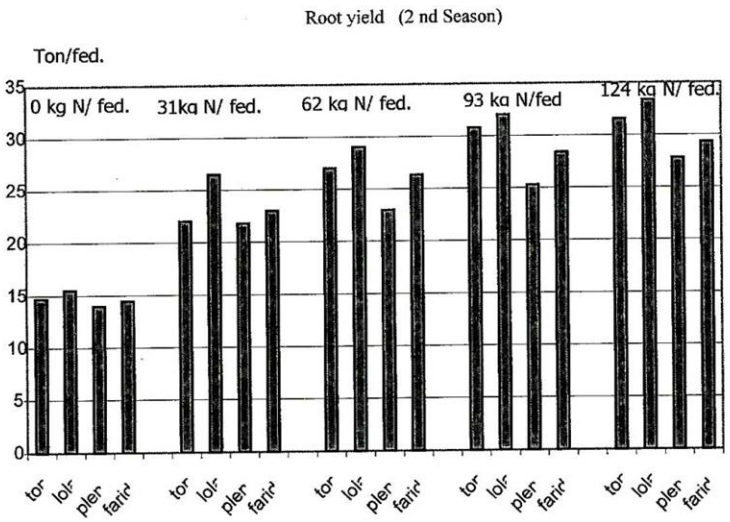
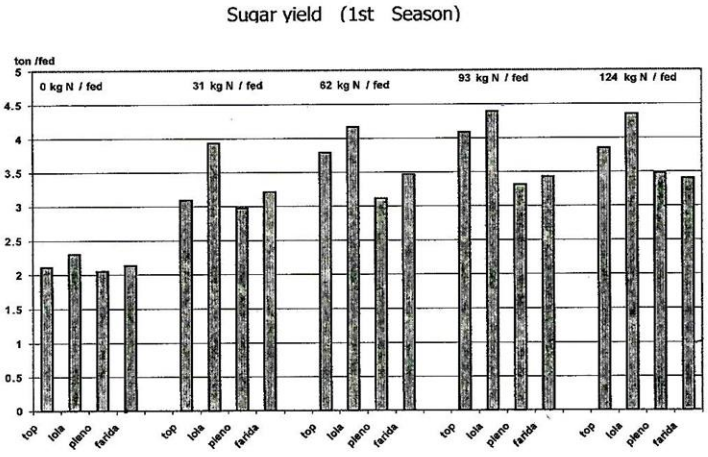
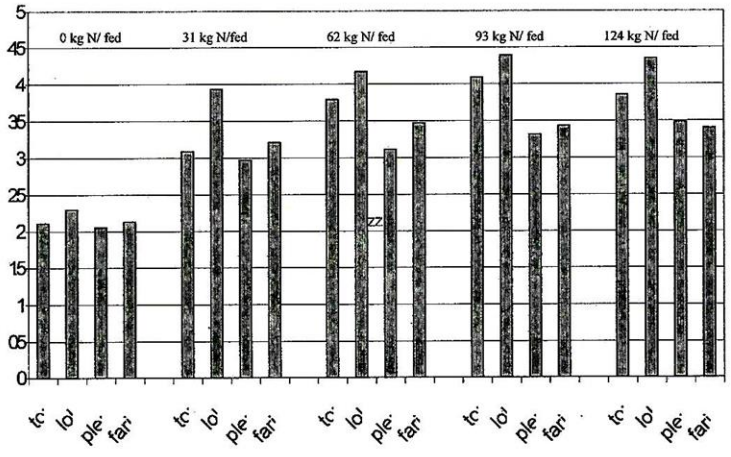


Fig 2. Sugar yield as effected by varieties and nitrogen fertilizer





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تأثير التسميد الآزوتي على محصول وجودة بعض أصناف بنجر السكر

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أجريت هذه الدراسة في محطة التجارب الزراعية بكلية الزراعة جامعة القاهرة خلال موسمي ٢٠٠١/٢٠٠٢- ٢٠٠٢/٢٠٠٣ وذلك لدراسة استجابة بعض أصناف بنجر السكر (توب ، لولا، بلييتو،فريدا) للتسميد الآزوتي
(صفر- ٣١- ٦٢- ٩٣- ١٢٤ كجم / فدان) . أوضحت النتائج أن الأصناف اختلفت فيما بينها في صفات الجودة ونسبة الشوائب والسكر المفقود في المولا س وكذلك المحصول ومكوناته وتفوق الصنف لولا عن الأصناف الأخرى في نسبة كل من السكروز والنقاوة والسكر المصحح ومتوسط وزن الجزر الواحد وكذلك محصول الجذور والسكر في كلا الموسمين وكان الصنف فريدا اكثر الأصناف في عدد النباتات أعلى في محصول العرش للفدان.

أدى زيادة التسميد الآزوتي حتى ١٢٤ كجم / للفدان إلى انخفاض نسب السكروز والنقاوة و السكر المصحح وكذلك النسبة المئوية لجودة البنجر بينما زاد محتوى الجذور من الشوائب والسكر المفقود في المولاس وكذلك أدي زيادة التسميد الآزوتي ألي زيادة متوسط وزن الجذر الواحد و عدد الجذور ومحصول العرش والجذور للفدان. كما أوضحت النتائج أن زيادة التسميد الآزوتي عن المعدل ٩٣ كجم للفدان أدي ألي زيادة غير معنوية في محصول السكر.

كان التفاعل بين الأصناف والتسميد الآزوتي معنويا في جميع الصفات المدروسة فيما عدا نسبة السكروزومحتوى الجذور من الحامض الأميني .