EFFECT OF NITROGEN SOURCES AND LEVELS ON YIELD AND QUALITY OF SUGAR BEET

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Abstract

Two field trials were carried out at Sakha Research Station, Kafr El-Sheikh Governorate in 2001/2002 and 2002/2003 seasons to study the effect of six treatments represent three nitrogen sources [Urea (46% N), Ammonium Nitrate (33.5% N) and Amounim Sulfate (20.6% N)] and two nitrogen levels (69 and 115 kg N/fed). Sugar beet Gazella variety was planted. Treatments were distributed in a complete randomized block design in four replications.

The results showed that nitrogen sources significantly affected sugar yield and alpha amino nitrogen percentages while root length, root diameter, root fresh weight/plant, extractability percentage and root yield were not significantly affected by nitrogen sources. Nitrogen levels caused a significant effect on root diameter, root fresh weight/plant, sucrose %, root yield and alpha amino nitrogen % in both seasons and sugar yield in the 1st season.

INTRODUCTION

Nitrogen has an essential role in building-up plant organs through the synthesis of proteins and it is an integral part of the chlorophyll molecule. Also, it is important to the synthesis of sucrose and the reactions involving the utilization of sucrose as an energy sources for plant growth and cell maintenance.

Many investigators found that sugar beet yield and quality are greatly influenced by the applied N levels. Oga, *et al.* (1990) fertilized sugar beet with 75-225 kg N/ha. They found that the application of 150 kg N/ha gave the highest root yield and root sugar content, compared with untreated control. Rabuffetti *et al.* (1993) obtained a significant increase in root yield with increasing N fertilization. There were positive responses to N where the rate of N needed for maximum sugar yield was 15 to 20 kg/ha less than the rate required for maximum root yield. Besheit *et al.* (1994) applied three N rates (100, 125 and 150 kg/fed) to sugar beet. They observed that the highest N rate significantly increased individual root weight, root and sugar yields/fed and reduced sucrose and purity percentages. El-Maghraby *et al.* (1998) revealed that increasing N-levels from 30 to 60 and 90 kg N/fed gave a significant increase in root weight/plant, root and sugar yields/fed. They concluded that applying 90 kg N/fed had a superior effect on root and sugar yields. Ibrahim (1998) applied five N levels (0, 25, 50, 75 and 100 kg/fed). He found that 100 kg N/fed gave significantly the maximum values of root length, diameter, fresh weight/plant, root and sugar yields while sucrose and purity percentages were significantly decreased. Khan *et al.* (1998) noticed that sugar yield, sucrose and purity percentages of sugar beet cv. Ramonskaya increased with increasing N rates from 0, 60, 120 or 180 kg N/ha. Shalaby (1998) found that root fresh weight/plant, root and sugar yields were gradually increased as the N-rate was increased from 60, 75 and 90 kg/fed. However, purity percentage gradually decreased as N-levels increased. EL-Shafai (2000) showed that increasing N-levels up to 92 kg N/fed significantly increased root fresh weight/plant, root and sugar yields while sucrose percentage decreased. He added that purity percentage was not significantly affected by the applied N-levels. Nemeat Alla (2001) recommended that ammonium nitrate significantly increased root length, root diameter, root yield and sugar yield compared with urea and ammonium sulphate. Also, he added that nitogen sources showed no significant effect on total soluble solids, soucrose and juice purity percentages.

The aim of this work was to find out the best nitrogen levels and/or sources giving the maximum yield and highest quality characteristics of sugar beet.

MATERIALS AND METHODS

Two field trials were carried out at Sakha Research Station, Kafr El-Sheikh Governorate in 2001/2002 and 2002/2003 seasons to study the effect of six treatments represent the combination between three sources of nitrogen fertilizer (Urea, 46%, Ammonium Nitrate, 33.5% and Ammonium Sulfate, 20.6%) and two nitrogen levels (69 and 115 kg N/fed) on yield and quality of sugar beet. Nitrogen fertilizer levels were added in two equal doses: the 1st was applied immediately after thinning and the 2nd was added after one month. Gazella variety was used in both seasons. Treatments were distributed in a complete randomized block design in four replications. The previous crop was maize in both seasons. The physical and chemical analysis of the upper 30-cm of soil of the experimental site showed that the soil was clay loam containing 29.73 ppm available N, 25.2 ppm P and 346 ppm K. Other agricultural practices were done as recommended by Sugar Crops Research Institute.

Data recorded

At harvest, ten plants from each treatment were randomly collected to determine the following traits:

1. Root length (cm).

2. Root diameter (cm).

3. Root fresh weight/plant (kg).

Juice quality characteristics were determined in the fresh roots using an automatic French system called (HYCEL):

4. Sucrose percentage (Pol. %) was determined using polarimeter on a lead acetate extract of fresh macerated root according to the method of Le-Doct (1927).

5. Alpha (α) amino nitrogen was determined using Ninhydrin, Hydrindantin metyhod according to the method of Carruthers, *et al.* (1962).

6. Extractability % = extractable sugar / sucrose %.

Where: Extractable sugar % = V_4 - SM - 0.6, Dexter *et al.* (1967),

Sugar loss to molasses (SM) = (V_1+V_2) 0.14 + V_1 x 0.25 + 0.5, Devillers (1988).

7. Root yield (tons/fed) was determined on the whole plot basis.

8. Sugar yield (tons/fed) was calculated according to the following equation:

Sugar yield = root yield x sucrose % x purity %.

The collected data were statistically analyzed according to the method described by Snedecor and Cochran (1981).

RESULTS AND DISCUSSION

1. Root length:

Data in Table (1) showed that N sources, N levels and their interaction did not significantly affect root length in both seasons. The addition of ammonium sulphate positively affected the root length comparing to ammonium nitrate and urea as well as the high rate of nitrogen increased the root length of sugar beet in both seasons.

Table 1. Effect of nitrogen sources and levels on root length (cm) Of sugar beet in 2001/2002 and 2002/2003 seasons.

Nitrogen sources	2001-2002 season Nitrogen levels (kg N/fed)			2002-2003 season Nitrogen levels (kg N/fed)		
	69	115	Mean	69	115	Mean
Urea	24.5	27.2	25.8	26.2	28.7	27.5
Ammonium nitrate	27.5	30.2	28.8	26.7	28.7	27.7
Ammonium sulphate	27.5	29.0	28.2	29.7	32.7	31.5
Mean	26.5	28.8	27.6	27.5	30.1	28.8
LSD at 5%						
Sources		NS			NS	
Levels		NS			NS	
Sources x levels interaction		NS			NS	

2. Root diameter

The results in Table (2) revealed that root diameter was not significantly affected by N sources in both seasons, while increasing N level markedly increased this trait in both seasons. The increase in root diameter was 15.38 and 16.23% in the 1st and 2nd season, respectively. This increase may be due to the role of nitrogen in building up plant organs in sugar beet plants. Similar results were recorded by Ibrahim (1998) and Nemeat Alla (2001).

The interaction effect between N sources and levels was not significant on root diameter in both seasons.

Table 2. Effect of nitrogen sources and levels on Root diameter (cm) of sugar beet in 2001/2002 and 2002/2003 seasons.

Nitrogen sources	2001-2002 season Nitrogen levels (kg N/fed)			2002-2003 season Nitrogen levels (kg N/fed)		
	69	115	Mean	69	115	Mean
Urea	12.3	14.3	13.3	11.2	13.0	12.1
Ammonium nitrate	11.3	12.5	11.8	12.5	13.5	13.0
Ammonium sulphate	11.7	14.0	12.8	11.5	14.5	13.0
Mean	11.7	13.5	12.6	11.7	13.6	12.6
LSD at 5%						
Sources		NS			NS	
Levels		1.745			0.840	
Sources x levels interaction		NS			NS	

3. Root fresh weight/plant

Data in Table (3) illustrate that root fresh weight/plant was not significantly affected by N sources in both seasons.

Increasing N level markedly increased root fresh weight/plant in both seasons by 52.57 and 30.03% in the 1st and 2nd season, respectively. This increase may be due to the increase in root diameter. Similar results were recorded by Besheit *et al.*

(1994), El-Maghraby *et al.* (1998), Ibrahim (1998), Shalaby (1998) and EL-Shafai (2000).

The interaction between N sources and levels had insignificant effect on root fresh weight/plant in both seasons.

Table 3. Effect of nitrogen sources and levels on root fresh weigh/plant (kg) of sugar beet in 2001/2002 and 2002/2003 seasons.

Nitrogen sources	2001-2002 season			2002-2003 season		
	Nitrogen levels (kg N/fed)			Nitrogen levels (kg N/fed)		
	69	115	Mean	69	115	Mean
Urea	1.200	1.740	1.470	1.225	1.625	1.425
Ammonium nitrate	0.965	1.425	1.195	1.175	1.425	1.300
Ammonium sulphate	1.100	1.815	1.458	1.175	1.300	1.388
Mean	1.088	1.660	1.374	1.192	1.550	1.371
LSD at 5%						
Sources	NS			NS		
Levels	0.213			0.189		
Sources x levels interaction	NS			NS		

4. Sucrose percentage

The results in Table (4) revealed that sucrose% was significantly influenced by N sources in the 1st season only. Urea application gave the maximum value of this trait (11.9%).

Increasing N levels from 69 up to 119 kg N/fed decreased sucrose % by 11.11 and 14.63% in the 1st and 2nd seasons, respectively. This reduction in sucrose % may be due to the fact that increasing the applied nitrogen rate results in increasing water retention by the tap root and in turn decreases sucrose % of root fresh weight (Draycott, 1993). This result is in agreement with that reported by Besheit *et al* (1994).

The interaction effect between N sources and levels was insignificant on sucrose percentage in both seasons.

Table 4. Effect of nitrogen sources and levels on sucrose percentage of sugar beet in 2001/2002 and 2002/2003 seasons.

Nitrogen sources	2001-2002 season Nitrogen levels (kg N/fed)			2002-2003 season Nitrogen levels (kg N/fed)		
	69	115	Mean	69	115	Mean
Urea	12.7	11.1	11.9	12.3	10.1	11.2
Ammonium nitrate	10.6	9.3	9.9	12.3	10.7	11.5
Ammonium sulphate	11.9	10.8	11.3	12.4	10.7	11.6
Mean	11.7	10.4	11.1	12.3	10.5	11.4

LSD at 5%	2001-2002 season	2002-2003 season
Sources	0.835	NS
Levels	0.682	0.917
Sources x levels interaction	NS	NS

5. Alpha amino nitrogen percentage

The results in Table (5) showed that alpha amino nitrogen percentage was significantly affected by N sources in both seasons. Ammonium nitrate recorded the lowest value of alpha amino nitrogen percentage.

Alpha amino nitrogen% was significantly increased by increasing N-levels from 69 to 115 kg N/fed by 30.23% and 64.51% in the 1st and 2nd seasons, respectively.

The interaction between N sources and levels had insignificant effect on alpha amino nitrogen% in both seasons.

Table 5. Effect of nitrogen sources and levels on alpha amino nitrogen% of sugar beet in 2001/2002 and 2002/2003 seasons.

Nitrogen sources	2001-2002 season Nitrogen levels (kg N/fed)			2002-2003 season Nitrogen levels (kg N/fed)		
	69	115	Mean	69	115	Mean
Urea	0.59	0.68	0.63	0.42	0.65	0.54
Ammonium nitrate	0.29	0.45	0.37	0.19	0.30	0.24
Ammonium sulphate	0.41	0.56	0.49	0.34	0.57	0.45
Mean	0.43	0.56	0.49	0.31	0.51	0.41
LSD at 5%						
Sources		0.119			0.165	
Levels		0.097			0.135	
Sources x levels interaction		NS			NS	

6. Extractability percentage

Data presented in Table (6) showed that N sources, N levels and their interaction did not significantly affect the extractability % in both seasons.

Table 6. Effect of nitrogen sources and levels on extractability% of sugar beet in 2001/2002 and 2002/2003 seasons.

Nitrogen sources	2001-2002 season			2002-2003 season		
	Nitrogen levels (kg N/fed)			Nitrogen levels (kg N/fed)		
	69	115	Mean	69	115	Mean
Urea	85.20	83.97	84.58	82.23	77.86	80.04
Ammonium nitrate	84.97	83.58	84.27	82.22	86.09	84.15
Ammonium sulphate	84.56	86.91	85.73	80.39	85.66	83.02
Mean	84.91	84.82	84.86	81.61	83.20	82.41
LSD at 5%						
Sources		NS			NS	
Levels		NS			NS	
Sources x levels interaction		NS			NS	

7. Root yield

Data in Table (7) illustrated that root yield was not significantly affected by N sources in both seasons.

Increasing N levels markedly increased root yield in both seasons by 12.28 and 10.12% in the 1st and 2nd season, respectively. This increase may be due to the increase in root diameter. Similar results were recorded by Oga *et al.* (1990), Rabuffetti *et al.* (1993) , Besheit *et al.* (1994), El-Maghraby *et al.* (1998), Ibrahim (1998), Shalaby (1998), Khan *et al.* (1998), El-Shafai (2000) and Nemeat Alla (2001).

The interaction between N sources and levels had insignificant effect on root yield in both seasons.

Table 7. Effect of nitrogen sources and levels on root yield (tons/fed) of sugar beet in 2001/2002 and 2002/2003 seasons.

Nitrogen sources	2001-2002 season			2002-2003 season		
	Nitrogen levels (kg N/fed)			Nitrogen levels (kg N/fed)		
	69	115	Mean	69	115	Mean
Urea	24.097	27.127	25.612	27.215	29.680	28.447
Ammonium nitrate	24.390	27.135	25.762	26.045	29.945	27.995
Ammonium sulphate	22.907	25.900	24.404	27.965	29.820	28.892
Mean	23.798	26.721	25.259	27.075	29.815	28.445

LSD at 5%	2001-2002	2002-2003
Sources	NS	NS
Levels	1.395	1.038
Sources x levels interaction	NS	NS

8. Sugar yield

Data collected in Table (8) showed that nitrogen sources positively and significantly affected sugar yield in the first season only. Urea application gave the highest mean value (2.856 tons /fed) of sugar yield followed by ammonium sulphate and amonium nitrate. This increase in sugar yield could be due to the increase in sucrose percentage (Table 4).

Sugar yield was significantly decreased by 8.96% when N-levels increased from 69 to 115 kg N/fed in the 2nd season. This reduction may be due to the fact that increasing the applied nitrogen rate results in increasing water retention by the tap root and in turn decreases sucrose % of root fresh weight (Draycott, 1993). This result is in agreement with that reported by Besheit *et al.* (1994).

The interaction between N sources and levels had insignificant effect on sugar yield in both seasons.

Table 8. Effect of nitrogen sources and levels on sugar yield(tons/fed) of sugar beet in 2001/2002 and 2002/2003 seasons.

Nitrogen sources	2001-2002 season			2002-2003 season		
	Nitrogen levels (kg N/fed)			Nitrogen levels (kg N/fed)		
	69	115	Mean	69	115	Mean
Urea	2.898	2.815	2.856	3.340	2.977	3.159
Ammonium nitrate	2.484	2.395	2.439	3.200	2.803	3.001
Ammonium sulphate	2.627	2.613	2.620	3.060	2.958	3.009
Mean	2.670	2.608	2.639	3.200	2.913	3.057
Lsd at 5%						
Sources		0.142			NS	
Levels		NS			0.298	
Sources x levels interaction		NS			NS	

REFERENCES

1. Besheit, S.Y. Mona M. Shehata and Samia S. El-Maghraby 1994. The use of nitrogen for sugar beet grown in sandy soil of Egypt. Egypt .J. Appl. Sci., 9(12): 225-231.

2. Carruthers, A., J.F. Toldfield and H.j. Teague 1962. Assessment of beet quality. Paper presented to the 15th Annl. Tech. Conf., British Sugar Coorporation Ltd. 28pp.

3. Devillers, P. 1988. Prevision du sucre melasse. Sucrerie franases, 129, 190-200. (C.F. The Sugar Beet Crop: Science into Practice. Edited by Cooke, D.A. and R.K. Scott. Pub. 1993 by Chapman & Hall ISBN 0 412 25130 2, Chapter 15: Root quality & Processing, 571-617 pp).

4. Dexter, S.T., M.G. Frankes and F.W. Snyder 1967. A rapid and practical method of determining extractable white sugar as may be applied to the evaluation of agronomic practices and grower deliveries in the sugar beet industry.j. Am., Soc., Sugar beet Technol.14:433-454.

5. Draycott, A.P. 1993. Nutrition, 239-278 pp. in The Sugar Beet Crop: Science into Practice. Edited by Cooke, D.A. and R.K. Scott. Pub. 1993 by Chapman & Hall, 2-6 Boundary Row, London, SEI 8 HN,UK.

6. El-Maghraby, Samia S, Mona M. Shehata and Yusreya H. Tawfik 1998. Effect of soil and foliar application of nitrogen and potassium on sugar beet. Egypt. J. Agric. Res., 76(2): 665-679.

7. El-Shafai, A.M.A. 2000. Effect of nitrogen and potassium fertilization on yield and quality of sugar beet in Sohag. Egypt J. Agric. Res., 78(2): 759-767.

8. Ibrahim, M.F.M. 1998. The effect of some fertilization elements on the yield and quality of sugar beet. Ph.D. Thesis, Fac. Agric., Moshtohor, Zagazig Univ., Egypt.

9. Khan, M.A.A. R.A. Singhania B. Hameedunnisa K. Lakshminarayana T. Srinivas and H. Begum 1998. Effect of nitrogen and phosphorus fertilization on nutrient status and uptake in sugarbeet. Intern. J. Tropical Agric., 14(1-4): 169-175.

10. Le docte, A. 1927. Commercial determination of sugar in beet root using the sacks. Le Docte proccess. Int. Sugar J., 29: 488-492.[C.F. Sugar beet Nut., April 1972 Appl. Sci. Pub. LTD, London, A.P.Draycott].

11. Nemeat, Alla E.A.E. 2001. Yield and quality of sugar beet as affected by sourcess, leveels and time application of nitrogen fertilizer.J.Agric.Res.Tanta Univ.27(3) :450-462.

12 . Oga, T.S. Ya.Ya. Limputsis and Y. Shtikans 1990. Yield and technological qualities of sugarbeet with increasing fertilizer rates. Udobrenie polevykh kul'tur-v-sisteme intensivnogo zemledeliya. 1990: 140-145.

13. Rabuffetti-A, Labuonora-D, Gallardo-Lancho-JF 1993. Responses of sugarbeet to NPK fertilizers and other productivity factors in the northeast of Uruguay. El estudio del suelo y de su degradacion en relacion con la desertificacion. Actas del 12 Congreso Latinoamericano de la Ciencia del Suelo, Salamanca, Sevilla (Espana) 19 a 26 de Septiembre de 1993., 1381-1390.

14. Shalaby, N.M.E 1998. Effect of different nitrogen levels and the period of no irrigation before harvesting on yield and quality of sugar beet. M.Sc. Thesis, Agron. Dept., Fac. Agric., Al-Azhar Univ., Egypt.

15. Snedecor, G.W. and W.G. Cochran 1981. Statistical Methods. Seventh Ed. Iowa State Univ. Press, Ames., Iowa, USA.

تأثير مصادر ومعدلات التسميد النيتروجينى على محصول وجودة بنجر السكر

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أقيمت تجربتان حقليتان بمحطة بحوث سخا بكفر الشيخ خلال موسمى ٢٠٠١– ٢٠٠٢ و٢٠٠٢–٢٠٠٣ واشتملت الدراسة على ثلاثة مصادر للسماد الينتروجينى (يوريا٤٦% ، نترات آمونيوم ٣٣,٥ % و سلفات آمونيوم ٢٠,٦%) ومستويان للتسميد النيتروجينى (٦٩ و١١٥ كجم ن/ فدان) وقد أستخدم تصميم القطاعات الكاملة العشوائية فى أربع مكررات وكان الصنف المستخدم فى البحث جازيلا.

وقد أوضحت نتائج التجربة ما يلى:

١– أثرت صور التسميد النيتروجينى معنويا على صفات النسبة المئوية للسكروز ومحصول السكر والنسبة المئوية للألفا أمينو نيتروجين بينما لم تتأثر صفات طول وقطر والوزن الطازج للجذر ومحصول الجذور والنسبة المئوية للإستخلاص معنويا بأى من صور السماد النيتروجينى المستخدمة فى البحث.

٢– تأثرت صفات قطر الجذر والوزن الطازج للجذر والنسبة المئوية للسكروز ومحصول الجذور ومحصول السكر والنسبة المئوية للألفا أمينو نيتروجين معنويا بمستويات النيتروجين المدروسة بينما لم تتأثر صفتا طول الجذر والنسبة المئوية للإستخلاص.

تحت ظروف هذا البحث يوصى باستخدام السماد االنيتروجينى سواء فى صورة يوريا أو نترات آمونيوم أو سلفات آمونيوم بمعدل ١١٥ كجم نيتروجين/فدان للحصول على أعلى محصول جذور للفدان. بينما يوصى باستخدام سماد اليوريا بمعدل ٦٩ كجم نيتروجين/فدان للحصول على أعلى محصول سكر للفدان.