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Sugar Beet Productivity as Influenced by Sources and Over Doses of Nitrogen Fertilizers Grown in Clay Soil

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ABSTRACT

Improving sugar beet productivity and sugar extracting process is considered main target by adjusting N rate and the appropriate source of N. Two split plot experiments with three replications were conducted at a Private Farm at Ferrmon village, Dessok Province, Kafer El-Sheikh Governorate during 2008/09 and 2009/10 seasons to study the effect of three sources of nitrogen fertilizers (Urea 46% N, ammonium Nitrate 33.3% N and ammonium sulphate 20.6 % N) with three levels (100, 150 and 200 Kg N fed^{-1}) on yield and quality of sugar beet grown on a clay soil. Results indicated that no significant differences were reported among sources of nitrogen fertilizer in the most of growth root parameters and yield except root weight (kg), white and molasses sugar yield (ton fed^{-1}). In contrary significant differences were recorded in quality, impurity, concentration of N in soil and nitrogen use efficiency (NUE) parameters except, Na, K/Na ratio and alkalinity coefficient as impurity and NUE for molasses sugar. However application of nitrogen as ammonium nitrate gave more value in the most of growth root, yield, quality and nitrogen use efficiency parameters while gave lowest value for impurity parameters and residual of N in soil. Application of different over doses of nitrogen fertilizers significantly affected tested parameters except fresh root, whit, and molasses yield and. Generally, these results clearly emphasize the application the proper source of nitrogen could effectively maximize the potential sugar extraction process like ammonium nitrate while the others like ammonium sulphate may detract sugar production . Also, it seems that application rate of 150kgN did not affect sugar extraction and resulted in less soil residual ,consequently less environmentally pollution

Key words: Sugar beet, Nitrogen fertilizers, Sources, Rates, Quality, yield,

Introduction

Sugar beet (*Beta vulgaris* L.) is ranked as the second most important sugar crop after sugar cane In Egypt, as it is cultivated in more than 63 thousand hectares, with an average production of 50 tons/hectare (FAO, 2011). Recently, sugar beet crop has been an important position in Egyptian crop rotation as a winter crop not only in fertile soils, but also in poor, saline, alkaline and calcareous soils. Approximately 66 % of our local needs are produced locally from sugar beet and sugar cane while, the rest (34 %) is imported from foreign countries (FAO, 2011). Moreover, sugar beet is considered one of the most important crops, not only for sugar production but also for fodder and organic matter for the soil. It is also considered as a double benefit crop to the farmers, where the roots are processed for sugar production and the green leaves and tops are used for animal feeding.

Improving crops productivity especially sugar beet is considered the main target for our Department by adjusting the appropriate cultural agricultural treatment periodically especially for new imported cultivars. Agricultural treatments i.e., cultivation methods, planting dates, type and amount of fertilizer, irrigation and harvesting are considered of the main determinants of the productivity of sugar beet crop (Technical Bulletin of the Ministry of Agriculture 2001). Nitrogen fertilizer comes on top of these treatments where many studies confirm the importance of the element nitrogen to increase the quantity and quality of sugar beet (El-Harriri and Mervat 2001; Zalat *et al*., 2002 ; Ramadan *et al*., 2003; Azzazy, 2004)

This study aimed to optimize sugar beet productivity by adjusting the appropriate application of sources and levels of chemical nitrogen fertilizers.

Materials and Methods

Two split plot experiments with three replications were conducted at a Private Farm, Ferrmon Village, Dessok Province, Kafer El-Sheikh Governorate during 2008/09 and 2009/10 seasons to study the effect of three sources of nitrogen fertilizers (Urea 46% N, Ammonium Nitrate 33.3% N and Ammonium sulphate 20.6 %N)

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with three levels (100, 150 and 200 Kg N fed^{-1}) on yield and quality of sugar beet plant grown on a clay soil. Sources and levels of nitrogen fertilizes were allocated randomly in main and sup plot; respectively. The experimental unit consisted of 7 ridges 50 cm apart and 8 meters a long (28 m^2). The preceding summer crop was rice (Variety Giza-177) in both seasons.

The soil was ploughed triple, settled, ridged and divided into plots. During soil preparation, the recommended dose of phosphorus fertilizer was applied at a level of 200 kg calcium super phosphate fed^{-1} (15.5% P_2O_5). Two-three of sugar beet seed balls "cv. Oscarpoly" was sown in hill spaced 20 cm on one side of ridge (50 cm apart) on August 28st and September 1th in the first and second seasons; respectively. Plots were flooded irrigated immediately after sowing. Plants were thinned twice and the later one was done to ensure one plant/hill (36000 plants fed^{-1}). Potassium in the form of potassium sulphate (48 % K_2O) was added at the rate of 120 kg fed^{-1} in two equal doses after thinning and 21 days later, respectively. Nitrogen fertilizer treatments were added in three equal doses after thinning (35 days from sowing), 21 and 42 days later, respectively. Other agricultural practices were kept the same as normally practiced in growing sugar beet fields.

At harvest, Plants in the four inner ridge of each plot were collected and cleaned, therefore roots was separated and weighted in kilograms and converted to estimate root yield (ton fed^{-1}). Sugar yield (ton fed^{-1}) was calculated by multiplying root yield by root sucrose percentage.

A sample of 10 kg of roots were taken at random from each plot and sent to the Beet Laboratory at Hamool Sugar Factory to determine root quality. Alpha amino nitrogen (α- amino N), sodium (Na) and potassium (K) concentrations were estimated according to the procedure of Sugar Company by Auto Analyzer described by Cooke and Scott (1993). Sucrose (expressed as Pol %) was estimated in fresh samples of sugar beet root by using Saccharometer according to the method described by A.O.A.C. (1995). Sugar loss was calculated using the following formula: Sugar loss % = [(0.29) + 0.343 (K + Na) + (0.094 α-amino N)]., Sugar recovery % was calculated using the following equation: Sugar recovery (%) = sucrose (%) - sugar loss (%) (Cooke and Scott (1993). Recoverable sugar yield (ton ha^{-1}) was calculated using the following equation of Mohamed (2002): Recoverable sugar yield = root yield (ton fed^{-1}) x sugar recovery. Quality index was calculated as (sugar recovery % x 100)/sucrose %. Gross sugar yield (ton fed^{-1})= root yield (ton fed^{-1}) x sucrose %. Sugar loss yield was computed as: root yield (ton fed^{-1}) x sugar loss (%).

The analysis of variance of split plot experiment was carried out using MSTAT-C Computer Software (MSTAT, 1988), after testing the homogeneity of the error according to Bartlett's test, combined analysis for both seasons were done. Means of the different treatments were compared using the least significant difference (LSD) test at $P<0.05$.

Results and Discussions

Yield and root parameters:

Data presented in Table 1 indicated that nitrogen fertilizer sources significantly affected root weight (kg), fresh root (ton/fed.) and gross sugar (ton/fed.) in combined over both seasons. However, root diameter and length (cm), fresh foliage (ton/fed.), white and molasses sugar (ton/fed.) were not significantly affected by nitrogen fertilizer sources. Fertilization with ammonium nitrate (33.5 % N) gave the maximum values of root weight (1.4 kg), fresh root weight (30.89 ton/fed.) and gross sugar weight (5.94 ton/fed.). The effect of nitrogen fertilizer sources as ammonium nitrate on yield is mainly due to their effect on soil reaction and nutrient availability. These results are in agreement with those reported by Sharief *et al*. (2004), Ismail and Abo El-hgait (2005).

From the same table, the combined results over both seasons for root characters and yield showed that nitrogen level with different rates showed significant changes for root (diameter, length and weight) and fresh foliage (ton/fed.). Application of 200 kg N/fed soil gives the highest root diameter, length and weight and fresh foliage (16.91cm, 39.16cm, 1.47kg and 15.81 ton/fed.). However the dose of 100 N kg^{-1} gives the lowest diameter, weight, length and fresh foliage. Positive effect of increasing N doses on shoot and root weight may be due to the role of nitrogen in development and survival of new tillers, through synthesis of nucleic acids and other organelles (Allam, 2003). Amin (2005) reported that increasing N levels significantly increased root length and its diameter, root fresh weight, top, root and sugar yield. Bell *et al*. (1992) in UK, suggested that the highest nitrogen fertilizer rate (180 kg N/ha) decreased the final sugar concentration in storage roots. EL-Kassaby and Leilah (1992 a) in Egypt, stated that increasing nitrogen rate up to 60 kg N/fad caused obvious effect on root fresh weight sugar yields/fad. Bell *et al*. (1992) in UK suggested that the highest nitrogen fertilizer rate decreased the final sugar concentration in storage roots.

Regarding the interaction between nitrogen sources and its rates, combined data over both seasons in table (1) showed that is no significant changes of the interaction between nitrogen source and its rates on root diameter, root length, root weight, fresh root, fresh foliage and gross sugar. However, significant results of white sugar and molasses sugar in 2009/10 were observed where the highest white sugar was observed with 150 kg N as ammonium nitrate/fed, while highest molasses sugar was found with 200 kg N as ammonium sulfate/fed. It could be stated that using ammonium nitrate or sulfate as a sources of nitrogen fertilizer at level 150 kg/fed. Surpassed those used urea at the same rate in root yield/fed. This result may be due to either that ammonium nitrate and sulfate is a source of NO^{-3} and NH^{+4} which is more readily taken up by plants than urea from soil or the inferiority of urea my be due to a considerable loss of N-urea out root zone either by leach or volatilization (Ismail and Abo El-Hgait 2005)

Table 1: Effect of different sources and rates of nitrogen fertilizers on root parameters and yield (ton fed^{-1}) of sugar beet grown in clay soil (combined data over both seasons).

Sources	Levels (kg N/fed)	Diameter (cm)	Length (cm)	Weight (kg)	Fresh root	Fresh foliage	Gross sugar	White sugar	Molasses sugar
	Parameter	Root parameter			Yield (ton fed^{-1})				
Ammonium sulfate (20.6 %N)	100	13.90	37.24	1.15	29.29	14.55	5.38	3.35	1.10
	150	16.16	37.38	1.30	29.45	14.88	5.49	2.92	1.20
	200	17.06	39.06	1.42	31.42	15.62	5.66	3.66	1.23
Ammonium nitrate (33.3%N)	100	15.00	36.62	1.18	30.18	14.82	6.10	3.64	1.21
	150	15.66	37.69	1.47	30.88	15.60	5.97	3.72	1.00
	200	16.94	39.72	1.57	31.60	15.95	5.76	3.47	1.01
Urea (46 %N)	100	14.47	37.26	1.10	29.20	14.28	5.79	3.59	0.98
	150	15.16	36.85	1.26	30.08	15.25	5.66	3.38	1.05
	200	16.73	38.69	1.42	30.60	15.85	5.31	2.80	1.17
LSD at 5%		ns	ns	ns	ns	ns	ns	0.43	0.18
Sources	A. sulfate	15.71	37.89	1.29	30.05	15.02	5.51	3.31	1.18
	A. nitrate	15.86	38.01	1.40	30.89	15.45	5.94	3.61	1.07
	Urea	15.46	37.60	1.26	29.96	15.12	5.59	3.26	1.07
LSD at 5%		ns	ns	0.07	0.76	ns	0.22	ns	ns
Levels (kg N/fed)	100	14.46	37.04	1.14	29.55	14.55	5.75	3.53	1.10
	150	15.66	37.30	1.34	30.14	15.24	5.71	3.34	1.09
	200	16.91	39.16	1.47	31.20	15.81	5.58	3.31	1.14
LSD at 5%		0.82	1.78	0.12	ns	0.83	ns	ns	ns

*Data of white and molasses sugar recorded at 2009/10 season.

Sugar extraction and quality parameters

Significant differences were obtained due to nitrogen sources with different rates on the most of sugar beet extraction process and quality parameters (Table 2). Nitrogen sources, significantly affected total soluble solids, molasses sugar, white sugar and quality index (%).The highest TSS (18.77%), sucrose (19.04 %), white sugar (13.63 %) and quality index (77.00%) were obtained with ammonium nitrate, while molasses sugar was high (4.54 %) with ammonium sulfate. However ammonium sulfate gave the lowest TSS (17.43%), sucrose (18.20 %), white sugar (12.76 %) and quality index (73.64%), while ammonium nitrate gives the lowest molasses sugar (4.07 %). These results are in harmony with those obtained by Ismail and Abo El-hgait 2005. These results clearly emphasize the application the proper source of nitrogen could effectively maximize the potential sugar extraction process like ammonium nitrate while the others like ammoniu m sulphate may detract sugar production .

Table 2: Influence of different sources and rates of nitrogen fertilizers on some quality parameters of sugar beet grown in clay soil at 2009/10 season.

Sources	Levels (kg N/fed)	TSS	*Sucrose	Molasses sugar	White sugar	Quality index
	Parameter	Quality parameters (%)				
Ammonium sulfate (20.6 %N)	100	18.60	18.25	4.31	13.09	75.20
	150	17.10	18.40	4.82	11.78	70.89
	200	16.60	17.95	4.50	13.40	74.82
Ammonium nitrate (33.3%N)	100	19.50	20.00	4.61	13.89	75.05
	150	18.50	19.12	3.84	14.16	78.59
	200	18.30	18.00	3.75	12.85	77.37
Urea (46 %N)	100	17.70	19.59	3.89	14.25	78.59
	150	16.70	18.65	4.17	13.43	76.26
	200	18.30	17.07	4.46	10.74	70.63
LSD at 5%		0.87	ns	0.36	0.53	2.03
Mean of Main effects						
Sources	A. sulfate	17.43	18.20	4.54	12.76	73.64
	A. nitrate	18.77	19.04	4.07	13.63	77.00
	Urea	17.57	18.44	4.17	12.81	75.16
LSD at 5%		0.92	0.36	0.26	0.55	1.92
Levels (kg N/fed)	100	18.60	19.28	4.27	13.74	76.28
	150	17.43	18.72	4.28	13.12	75.25
	200	17.73	17.67	4.24	12.33	74.27
LSD at 5%		0.50	0.73	ns	0.30	1.17

*Data of sucrose (%) over both 2008/09 and 2009/10 seasons.

Concerning nitrogen levels, data in the same table showed that nitrogen rates exhibited significant result for all quality parameter except molasses sugar. Application of 100 kg N/fed gave the highest TSS (18.60 %), sucrose (19.28 %), white sugar (13.74 %) and quality index (76.28 %); while the highest molasses sugar (4.28 %) was recorded with 150 kg N/fed. on the contrary, 200 kg N /fed. gives the lowest sucrose (17.67 %), molasses sugar (4.24 %), white sugar (12.33 %) and quality index (74.27 %), moreover the lowest TSS (17.73%) was obtained by adding 150 kg N/fed. for sugar beet plants. Sucrose yield decreases by over-fertilizing sugar beet with more N than needed for maximum sucrose production (Hassanin and Elayan, 2000). An adequate supply of N is essential for optimum yield but excess N may result in an increase in yield of roots with lower sucrose content and juice purity. Yield increased with applied but TSS, sucrose %, purity % and recoverable sugar yield per ha were significantly decreased as N level increased (Lauer, 1995; Badawi *et al*., 1995; Salama and Badawi, 1996 and El-Hennawy *et al*., 1998).

The interaction between sources and rates of nitrogen fertilizer significantly affected sugar beet quality except sucrose (Table 2). The highest values of TSS and sucrose (19.50 and 20.00 %) were achieved by adding ammonium nitrate at 100 kg N/fed., respectively. However, the lowest values of TSS and sucrose (16.60 and 17.07 %) were reported at 200 kg N/fed. of ammonium sulfate and urea, respectively. Application of ammonium nitrate at 150 kg N /fed gave the highest value of white sugar (14.16 %) and quality index (78.59 %), while the highest value of molasses sugar (4.82 %) was recorded at 150 kg N/fed as ammonium sulfate. Adding urea at 200 kg N/fed gave the lowest values of white sugar (10.74 %) and quality index (70.63 %), while 200 kg N/fed as ammonium nitrate gave the lowest value of molasses sugar (3.75 %). These results suggested that higher rates of nitrogen whether ammonium sulfate, ammonium nitrate and urea result in significant and marked increase all investigated impurities content. In this respect, several workers (Lauer, 1995; Badawi *et al*., 1995; Salama & Badawi, 1996 and El-Hennawy *et al*., 1998).

Impurity parameters:

The technical beet quality, *i.e.* the process ability in the sugar factory, however, is determined not only by sucrose concentration, but also by the concentrations of other constituents that impair white sugar recovery. These are called root impurities such as potassium, sodium, amino acids and other nitrogenous compounds as well as K+Na, K+Na/ α- amino-N, K/Na ratio and impurities index. Table (3) showed that, nitrogen fertilizer sources caused significant changes for K, α-amino-N, and impurity index, while Na, K/Na and alkalinity coefficient were not significant. The highest K and impurity index were recorded at ammonium sulfate, however the highest α-amino-N was recorded with ammonium nitrate. On the contrary, sources nitrogen fertilizer as urea gives the lowest K, α-amino-N, and impurity index. These results are in harmony with those obtained by Ismail& Abo El-hgait 2005.

Table 3: Effect of different sources and rates of nitrogen fertilizers on impurity parameters of sugar beet plants grown in clay soil at 2009/10 seasons.

Treatments		Impurity components (mmol 100g/beet paste)					
Sources	Rate (kg N/fed)	K	Na	α-Amino-N	K/Na	Alkalinity coefficient	Impurity index
Ammonium sulfate (20.6 %N)	100	6.00	4.53	4.28	1.33	2.47	4.24
	150	6.70	5.30	4.42	1.26	2.71	4.80
	200	5.60	5.40	4.67	1.04	2.36	4.45
Ammonium nitrate (33.3%N)	100	6.10	5.30	4.40	1.16	2.60	4.21
	150	4.80	4.30	4.54	1.12	2.01	4.03
	200	4.70	4.10	4.70	1.16	1.87	4.41
Urea (46 %N)	100	5.13	4.23	4.09	1.21	2.30	3.78
	150	4.93	5.20	4.31	0.95	2.35	4.19
	200	5.50	5.40	4.63	1.03	2.36	5.19
LSD at 5%		0.84	0.55	ns	ns	0.30	0.33
Mean of Main effects							
Sources	A. sulfate	6.10	5.08	4.46	1.21	2.51	4.50
	A. nitrate	5.20	4.57	4.55	1.14	2.16	4.22
	Urea	5.19	4.94	4.34	1.06	2.33	4.39
LSD at 5%		0.23	ns	0.14	ns	ns	0.17
Rate (kg N/fed)	100	5.74	4.69	4.26	1.23	2.46	4.08
	150	5.48	4.93	4.42	1.11	2.36	4.34
	200	5.27	4.97	4.67	1.07	2.20	4.68
LSD at 5%		ns	ns	0.24	0.13	0.17	0.19

Regarding the effects of N levels, significant changes were found among them in α-amino-N, K/Na, alkalinity coefficient and impurity (Table 3). The highest K, K/Na and alkalinity coefficient were led to 100 kg N/fed, while the highest Na, α-amino-N and impurity index were led to 200 kg N/fed. Badawi (1996), reported that raising nitrogen rates up to 80 kg N/fad caused a decrease in TSS, sucrose and juice purity percentages.

Ramadan (1997), showed that sucrose, juice purity and recoverable sugar percentages were decreased with all increase in nitrogen rate to 90 kg N/fad.

The same table show the interaction between sources and rates of nitrogen fertilizer significantly affected sugar beet impurity parameters except α-amino-N and K/Na. The highest values of K and alkalinity coefficient (6.70 and 2.71/100 m mol g/ beet paste) were achieved by adding ammonium sulfate at 150 kg N/fed, respectively. However, the lowest values of K and alkalinity coefficient (4.70 and 1.87/100 m mol g/ beet paste) were reported at 200 kg N/fed of ammonium nitrate, respectively. Application of urea at 200 kg N /fed gave the highest value of Na (5.40/100 m mol g/ beet paste) and impurity index (5.19/100 m mol g/ beet paste). Adding ammonium nitrate at 200 kg N/fed gave the lowest values of Na (4.10/100 m mol g/ beet paste) , while applying urea at 100 kg/fed gives the lowest value of impurity index (3.78/100 m mol g/ beet paste). These results suggested that higher rates of nitrogen whether ammonium sulfate, ammonium nitrate and urea result in significant and marked increase all investigated impurities content. In this respect, several workers (Lauer, 1995; Badawi *et al*., 1995; Salama and Badawi, 1996 and El-Hennawy *et al*., 1998).

Nitrogen residual in the soil (Total N, NH^4 and No^3):

Data in table (4) showed that the effects of nitrogen sources and rates on nitrogen residual in soil as a total N, NH_4 and NO_3. Significant changes in concentration of a total N, NH_4 and NO_3 were obtained among nitrogen sources. The lowest residual for NH^4 and NO^3 (ppm) in soil was recorded with added ammonium nitrate. However, the lowest total N (%) residual in soil were obtained with added nitrogen as a urea. In case of nitrogen level, 200 kg N/ fed^{-1} resulted in higher soil N content (22.70 , 27.10 (ppm) and 0.93 (%) for NH^4, NO^3 and total N, respectively), while 100 kg N/fed^{-1} resulted in the lowest residual for NH^4, NO^3 (ppm) and total N (%), 16.8, 14.50 and 0.72, respectively. Regarding the interaction between sources and rates of nitrogen fertilizer was also significant. The highest significant concentration of NH_4 (ppm) and total N (%) were found with 200 kg N/ fed-1 as ammonium sulfate (20.6 % N), while the highest significant concentration of NO_3 (ppm) was reported with 200 kg N/fed^{-1} as a urea (46 % N). however, the lowest amount of NH_4 (16.4 ppm), NO_3 (12.6 ppm) and total N (0.69 %) were produced with 100 kg N / fed-1 of ammonium nitrate (33 % N). High soil inorganic N with application of higher levels of N has also been reported by Rozas *et al*. (2004) who reported that mineral N was significantly greater for the highest N rates applied for maize plants at the end of the growing season. Similar results have been reported by Jokela and Randall (1989).

Table 4: Influence of different sources and rates of nitrogen fertilizers on total N, NH^4 and No^3 in soil during 2009/10 season.

Treatments		N sources concentration in soil		
Sources	Rate (kg N/fed)	NH_4 (ppm)	No_3 (ppm)	Total N (%)
Ammonium sulfate (20.6 %N)	100	17.60	13.90	0.76
	150	18.90	20.80	0.81
	200	25.20	28.40	1.12
Ammonium nitrate (33.3%N)	100	16.40	12.60	0.69
	150	17.00	17.60	0.83
	200	18.30	19.50	0.85
Urea (46 %N)	100	16.40	17.00	0.70
	150	16.42	18.90	0.76
	200	24.60	33.40	0.81
LSD at 5%		1.38	1.62	0.10
Mean of Main effects				
Sources	A. sulfate	20.57	21.03	0.90
	A. nitrate	17.23	16.57	0.79
	Urea	19.14	23.10	0.76
LSD at 5%		1.02	2.19	0.10
Rate (kg N/fed)	100	16.80	14.50	0.72
	150	17.44	19.10	0.80
	200	22.70	27.10	0.93
LSD at 5%		0.80	0.94	0.06

Nitrogen Use Efficiency:

Improvement of nutrients efficiency in crops is an important issue in modern agriculture both for reducing cost in agriculture production and for protecting the environment. Efficient use of nutrients is the relative ability of plant to produce maximal amounts of dry matter for each increment of nutrients accumulated or it is plant yield per unit nutrient supply (Saurbeck and Helal, 1990). Data in table (5) showed that significant difference ($p>0.05$) in nitrogen use efficiency (kg yield/kg N applied) among nitrogen source, except in white sugar. Where ammonium nitrate gave the highest value compared to the other two sources. In case of nitrogen levels, significant differences were recorded in all tested parameters. Application of 100 kg/N fed gave the highest value in comparison with application of 200 and 250 kg N/fed. Regarding the interaction between nitrogen sources and its levels, significant differences were reported in tested parameters except whit and molasses sugar. Generally, application of ammonium nitrate with 100 kg N/fed gave the greatest value compared to other treatments in all tested parameters. In this regards Barbanti *et al*. (1994) they suggested that intermediate applications of 60 or 120 kg N/ha proved to be the most effective nitrogen fertilizer application rates in terms of yield. Generally, higher fertilizer use efficiency reduced applied fertilizer and thus less nitrogen application cost (Terry, 2008 Jon, *et al*., 2009)

Table 5: Effect of different sources and rates on Nitrogen Use Efficiency (kg yield/kg N applied) of sugar beet grown in clay soil (combined data over both seasons).

Treatments		Nitrogen Use Efficiency (Kg yield/kg N applied)				
Sources	Levels (kg N/fed)	Fresh root	Fresh foliage	Gross sugar	White sugar	Molasses sugar
Ammonium sulfate (20.6 %N)	100	292.87	145.53	53.77	33.47	10.97
	150	196.30	99.18	36.62	19.47	8.02
	200	157.08	78.12	28.31	18.32	6.15
Ammonium nitrate (33.3%N)	100	301.82	148.15	60.97	36.37	12.10
	150	205.88	103.99	39.81	24.80	6.67
	200	157.98	79.74	28.78	17.35	5.07
Urea (46 %N)	100	291.95	142.78	57.88	35.93	9.83
	150	200.53	101.65	37.75	22.53	7.02
	200	152.99	79.24	26.57	14.00	5.84
LSD at 5%		ns	ns	ns	3.57	1.44
Mean of Main effects						
Sources	A. sulfate	215.42	107.61	39.57	23.75	8.38
	A. nitrate	221.89	110.63	43.19	26.17	7.94
	Urea	215.16	107.89	40.73	24.15	7.56
LSD at 5%		4.11	1.87	1.40	ns	0.26
Levels (kg N/fed)	100	295.54	145.49	57.54	35.26	10.97
	150	200.91	101.61	38.06	22.27	7.24
	200	156.01	79.04	27.89	16.56	5.69
LSD at 5%		10.92	6.54	3.59	2.06	0.83

*Data of white and molasses sugar recorded at 2009/10 season.

Conclusion

Under the condition of this experiment, it could be concluded that these results clearly emphasize that application the proper source of nitrogen like ammonium nitrate could effectively maximize the potential sugar extraction process while the others like ammoniu m sulphate may detract sugar extraction . while the others like ammoniu m sulphate may detract sugar production . Moreover it seems that application rate of 150kgN did not affect sugar extraction and resulted in less soil residual ,consequently less environmentally pollution

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References

A.O.A.C.(1995). Association of Official Analytical Chemists. Official methods of analysis, 16th edition, AOAC International, Washington, DC.

Allam, A. Y. (2003).Response of three wheat cultivars to split application of nitrogen fertilization rates in sandy soil. Assiut J of Agric. Sci., 34 (1): 1-14.

Allam, S.A.H.; Kh. El.Mohamed; G.S. El-Sayed and A.M.H. Osman (2005). Effect of sowing date, nitrogen fertilizer and row space on yield and quality of sugar beet crop. Annals of Agric. Sc. Moshtohor, 43(1): 11-24.

Amin, Gehan, A.M. (2005). Study of some agricultural practices on sugar beet.M.Sc.Thesis, Fac. of Agric., Zagazig Univ.

Anonymous. 2003. Agricultural Statistics . Vol.1. Ministry of Agriculture and Land Reclamation, Economic Affairs.

Azzazy, N.B., 2004. Effect of nitrogen and boron fertilization on yield and quality of sugar beet under new reclaimed soil condition. Egypt. J. Appl. Sci., 19(8): 1099-1113.

Badawi, M.A., 1996. Effect of soil and foliar fertilization with urea on yield, yield components and quality of sugar beet. (Beta vulgaris, L.). J. Agric. Sci. Mansoura Univ., 21 (9): 3083 - 3096.

Badawi, M.A., M.A. El-Agroudy and A.N. Attia, 1995. Effect of planting date and N P K fertilization on grow th and yield of sugar beet (Beta vulgaris, L.). J. Agric. Sci. Mansoura Univ., 20 (6): 2683 – 2689.

Barbanti, L., M. Bimbatti, U. Peruch, S. Poggiolini F. Rosso, M.T. Amaducci, S. Mambelli and G. Venturi 1994. Factors affecting sugar beet quality in the Po river Valley. Part 2: Nitrogen fertilization. Proc. of the 3rd Cong. of the European Soc. for Agron., Padova Univ., Abano-Padova, Italy, 18-22 Sept. pp. 574-575.

Bell, Ch. I., G.F.J. Milford, R.A. Leigh, 1996. Sugar beet. In: Zamski E., Schaffer A.A. (eds.): Photoassimilate distribution in plants and crops. Source-sink relation- ships. Marcel Dekker Inc., USA, New York: 691–707.

Cooke, D.A. and R.K. Scott, 1993. The Sugar Beet Crop, Science Practice published by Chapman and Hall, London.

El-Harriri, D.M. and M.E. Gobarah, 2001. Response of growth, yield and quality of sugar beet to nitrogen and potassium fertilizers under newly reclaimed sandy soil. J. Agric. Sci. Mansoura Univ., 26 (10): 5895-5907.

El-Hennawy, H.H., B.S.H. Ramadan and E.A. Mahmoud, 1998. Response of sugar beet to nitrogen fertilization levels and its time of application. J. Agric. Sci. Mansoura Univ., 23: 969-978

El-Kassaby, A.T. and A.A. Leilah, 1992a. Effect of sowing and harvesting time on yield and quality of sugar beet. Proc. 5th Conf. Agron. Zagazig, 13 – 15 Sept., Vol (2): 963 - 969.

FAO, 2011. http://faostat.fao.org/site/339/default.aspx

Hassanin, M.A. and S.E.D. Elayan, 2000. Effect of phosphours and nitrogen rates and time of nitrogen application on yield and juice quality of sugar beet. J. Agric. Sci. Mansoura Univ., 25: 7389-7398.

Ismail, A.M.A. and R.A. Abo El-Hgait, 2005. Effect of nitrogen sources and levels on yield and quality of sugar beet. Egypt J. Agric. Res. 83(1): 229-235.

Jokela, W.E. and G.W. Randall, 1989. Corn yield and residual soil nitrate as affected by time and rate of nitrogen application. Agron .J.81:720-726.

Jon, T., F. M. Biermacher, B. Epplin, B. Wade, B. John, S. William and R. Raun, 2009. Economic feasibility of site-specific optical sensing for managing nitrogen fertilizer for growing wheat. Precision Agric., 10: 213-230.

Lauer, J.G., 1995. Plant density and nitrogen rate effects on sugar beet yield and quality early in harvest. Agron. J., 87: 586–591

Leilah, A.A., M.A. Badawi, E.M. Said, M.H. Ghonema and M.A.E. Abdou, 2005. Effect of Planting Dates, Plant Population and Nitrogen Fertilization on Sugar Beet Productivity Under the Newly Reclaimed Sandy Soils in Egypt. Scientific Journal of King Faisal University (Basic and Applied Sciences), 6 (1): 85-110.

Mohamed, H.F., 2002. Chemical and technological studies on sugar beet. Ph.D. Thesis, Faculty of Agriculture, Minia University, Egypt.

MSTAT-C, 1988. MSTAT-C, a microcomputer program for the design, arrangement and analysis of agronomic research. Michigan State University, East Lansing.

Ramadan, B.S.H.; H.R. Hassan and A.A. Fatma, 2003. Effect of minerals and biofertilizers on photosynthetic pigments, root quality, yield components and anatomical structure of sugar beet (*Beta vuglaris* L.) plants grown under reclaimed soils. J. Agric. Sci. Mansoura Univ., 28: 5139-5160.

Rozas, S., H.E. Echeverria and P.A. Barbieri, 2004. Nitrogen balance as affected by application time and nitrogen fertilizer rate in irrigation No-tillage Maize. Agron .J.92: 1622-1631.

Salama, A.M. and M.A. Badawi, 1996. Evaluation of six sugar beet cultivars under N-levels and havesting dates. J. Agric. Sci. Mansoura Univ., 21: 139–153

Saurbeck, B.C. and H.M. Helal, 1990. Factors affecting the nutrients efficiency of plants. Bassam, N.E.L. (Ed) MartinusNijhoff, Dordrecht, 3: 361-372

Sharief, A. E., A.N. Attia, A. A. Salma and A.E. Mousa, 2004. Effect of nitrogen fertilizer sources and time of its splitting on root yield and quality of sugar beet in North Delta. The 4th Scientific Conference of Agricultural Sciences, Assiut, December, pp: 856-864.

Terry, L.R., 2008. Improving nutrient use efficiency. Turk. J. Agric. For., 32:177-182.

Zalat, S.S.; M.F. Ebrahama and B.M Abo El-Magd, 2002. Yield and quality of sugar beet (*Beta vulgaris* L.) as affected by bio and mineral nitrogen fertilization. J. Adv. Agric. Res., 7(3): 613-620.