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Effect of nitrogen sources, rates and boron on the absorbance of N, K, Na and B on the quality and productivity of sugar beet.

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ABSTRACT

To investigate the effect of nitrogen sources and nitrogen rate, and boron or without it on sugar beet yield and quality, two field experiments were carried out at the Experimental Farm of the Agriculture Research Centre, Tamia Research Station, Fayoum Governorate. Egypt, during the two successive seasons of 2016/2017 and 2017/2018. A split-split plot design was used in both growing seasons. Two nitrogen sources (anhydrous ammonia 82% and urea 46%) arranged in main plots, Three nitrogen rates (60, 75, and 90 kg N/fad) were devoted in sub-plots, whereas, sub-sub plots were allocated of boron applications at two rates of (without addition and addition 1 g/L of boron). The main results could be summarized as follows:

1-Nitrogen fertilization activated plant growth and increased its yield.

2- Nitrogen source as anhydrous ammonia showed the greatest growth (N, K, Na, and B) and yield while the lowest effective source was urea in 120 and 200days from planting,

3- By increasing the nitrogen rate from 60 to 90 kg /fed, led to an increase in the content of shoot and roots from N, K, Na, B and also increased the shoot and root dry and fresh weight and the yield of sugar was increased at the age of 120 days from planting as well as at the harvest, while this led to a decrease in the proportion of sucrose in the roots at harvest,

4- The addition of boron was superior to not adding it in all the studied traits such as root length and size and absorbed elements such as N, K, Na, and B, as well as the percentage of sugar and sugar yield per Fadden and the weight of roots and leaves in both seasons.

KEYWORDS

Sugar beet, Anhydrous Ammonia, Urea, Rates of nitrogen, Boron, Quality, productivity, uptake of nitrogen, potassium, Sodium, boron.

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1. INTRODUCTION

Sugar beet is the second crop in terms of sugar production in the world, as it follows the Amaranthaceae family, the percentage of sugar ranges between 14-20%, while sugar cane ranges between 10-13%, as well as in terms of water consumption as the Fadden of sugar cane it needs about 13100 m^3 of water, while sugar beet needs about 2950 m^3 of water, as well as where it resides in the ground, as sugar cane lasts 10-12 months, while sugar beet lasts 5-6 months**.** Nitrogen is a vital element for sugar beet growth, in many cases, nitrogen is a limiting factor because few soils contain sufficient nitrogen in an available form as nitrate or ammonium to provide for maximum growth at each stage of the crop. where the element is in short supply, fertilizer has a remarkable effect on the appearance of the crop, most noticeably by improving the colour and vigour of the leaf canopy, it has led to a widespread over-use of nitrogen. In many cases, this over-use decreases both sugar percentage and sugar extractability. **(Draycott, 2006)**

Boron in sugar beet is playing an important role which it was involved in hemicellulose, lignin structural, cell elongation and division, tissue differentiation and metabolism of carbohydrates, protein, auxin, and phenol, and in the end control of membrane permeability.

Boron (B) is the most important of the trace elements needed in sugar beet because, without adequate supply, the yield and quality of roots are very depressed **(Cooke and Scott, 1993)**. Boron is a unique non-metal micronutrient required for the normal growth and development of plants and is essential for the cell structure of plants, and the possible roles of B include sugar transport cell wall synthesis, lignification, cell wall structure integrity, carbohydrate metabolism, ribose nucleic acid (RNA) metabolism, phenol metabolism, and as of the cell membranes. Boron is absorbed by roots as undissociated boric acid (H_3Bo_3) and it is the only element that is taken up by plants not as an ion but as an uncharged molecule, and the factor affecting B uptake include soil type (texture, alkalinity/calcareousness, pH, organic matter content), B concentration, moisture, and plant species, and Boron is relatively immobile in the plant and thus its availability is essential at all stages of growth, especially during fruit/seed development **(Ahmad *et al*, 2012).**

Abashady *et al* (2011) observed that application of ammonia gas compared with urea as a source of nitrogen the ammonia gas was significantly increased alpha-amino N, Na, K root, sugar yield, and sucrose %. **Siam, Hanan *et al* (2012)** observed that used the ammonia gas with rates of 100,120 and 140 kg N/fed in corn plant the result showed that the ammonia gas with the high rate improved the all character N uptake, phosphorus uptake, and potassium uptake were increased over the control. **Ghazy (2013)** found that nitrogen sources had a significant effect on root length, crop growth rate, and net assimilation rate, and root fresh weight of sugar beet.

Abdelaal and Tawfik (2015) recorded that application of four nitrogen rates (

0,35,70 and 105 kg N/fed) to sugar beet plants, the highest values lead to higher values of root length and diameter, foliage and root fresh weights, and root yield/fed in the two seasons. However, the highest means of sucrose % and apparent purity % have resulted from the control treatment (0 kg N/fed) in the two growing seasons. **Abd El-Megeed (2017)** concluded that anhydrous ammonia (82%N) has increased significantly the rice plant and its components, dry matter, plant height, No.of tiller, and No.of panicle compared with urea (46 % N). **Attia and Khalifa (2015)** observed that the growth parameters and quality of sugar beet grown in newly soil to different nitrogen sources (ammonium sulfate %, ammonium nitrate, and urea 46%) and they found a significant effect of N-sources on the N, K, and Na% whether in the top or root in most cases at the growth stage. Uptake on N, K, Na, and B, sucrose was improved as a grown season progressive in both seasons. **Abbas *et al* (2018)** found that the decreased nitrogen rate from 100% to 75 % of recommended rate as 120kg N/fed in sandy soils as ammonium nitrate landed to significantly increased the sucrose % in two seasons respectively, on the other hand decreasing nitrogen rate significantly decreased the top yield and also root yield in the two-season respectively. **Moursi and Darwesh (2014)** observed that increasing the nitrogen rate from 30 to 90 kg N/fed to sugar beet plants led to an increase in root yield (ton/fed), top yield (ton/fed), root length (cm), root diameter (cm), sugar yield (ton/fed), N in tops % and N content in root % while sucrose % was decreased by increasing the nitrogen rate from 30 to 90 kg N/fed all parameter in the first and second season; respectively. **Abd El-Motagally (2016)** reported that the nitrogen fertilizer with rate 60.90 and 120 Kg N/fed and he conducted that applying the N application of 90 kg /fed was the best treatment which increasing the sugar yield by improving the root quality and found that no significant differences in K accumulation in sugar beet roots in both seasons, the highest mean values of α amino-N content in roots were consistently found in the plants grown in the highest N treat soil at 90 days after planting and similarly the accumulation of Na in sugar beet roots. **Lamani and Halikatti (2019)** showed that application of 180 kg N/ha increased yield and the quality parameter such as α-amino-N, K, P, and sucrose % were increased significantly while the root to shoot ratio and harvest index did not differ significantly. **Mostafa, Shafika** and **Darwish (2001)** studied the effect of four N levels,45, 75, and 105kg/fed. On sugar beet. They found that top and root yield was significantly increased with increasing N fertilizer up to 75kg N/fed. **Mostafa,Shafika** and **Darwish (2001)** studied the effect of nitrogen fertilizer levels 0, 45, 75, and 105kg N/fed. on sugar beet quality. They found that sucrose and purity % of sugar beet were decreased with increasing N-rate up to 105kg N/fed. **(Abd El-hady, 2018)** pointed that adding boron to sugar beet as a foliar spray and control treatment without boron under new reclaimed soil conditions, Sugar beet plants treated with Boron treatment gave the highest values of effective root length, root diameter, root fresh weight, leaves fresh weight and root/leaves ratio, On the other hand, the lowest values of the previous traits were recorded with the control treatment (without boron application). The highest values of root yield (34.63 ton/fad), top yield (7.773 ton/fad), sugar yield (6.00 ton/fad), sucrose percentage (18.86%), and extractable sugar percentage (17.33%), while the lowest values were recorded with control treatment (without boron application).

2. MATERIALS AND METHODS

Two field experiments were carried out during the winter seasons of 2016/2017 and 2017/2018 at the Experimental Station Farm of the Agriculture Research Centre, Tamia Research Station, Fayoum Governorate, Egypt, to evaluate the effect of different nitrogen sources (anhydrous ammonia 82% and urea 46%), nitrogen rates (60, 75 and 90 kg N/fad) and without and with boron their interaction on yield and components and chemical constituents of sugar beet (c.v *Gloria*). A representative soil sample (0-30 cm) was taken before planting to determine some physical, chemical, and nutritional properties (Table 1).

Table 1. Some physical and chemical analyses of the studied soil

Property	2016-2017	2017-2018	Property	2016-2017	2017-2018
Particle size distribution			**Ec in soil paste**	**4.67**	**4.61**
Coarse sand	14.45	15.50	Soluble ions (mmole L^{-1})		
Fine sand	23.56	22.37	Na^{+}	18.63	17.20
Silt %	21.25	19.40	K^{+}	4.13	3.52
Clay %	40.74	42.73	Ca^{++}	12.48	12.70
Texture Class	Clay Loam	Clay Loam	Mg^{++}	11.46	12.68
pH in soil paste	8.92	8.67	Cl^{-}	16.88	18.63
O.M %	0.50	0.58	Hco_3^{-}	4.86	4.99
$CaCo_3$ %	5.80	4.89	So_4^{-}	24.96	22.40

Available macro and micronutrients (mg kg^{-1})

	N	P	K	Fe	Mn	Cu	Zn	B
2016-2017	38.54	5.20	435	4.89	1.89	0.50	0.92	0.32
2017-2018	52.70	6.28	455	4.22	2.06	0.56	1.1	0.30

Nitrogen application sources were as follows: (anhydrous ammonia 82% and urea 46%), rate of them (60, 75, 90 KG N/fed) and (control and foliar application with Boron with rate 1 g /L). were added in three equal doses, Anhydrous ammonia fertilizer (82% N) was injected directly into the soil, at 15 cm depth with 30 cm spacing between the points of injection one week before planting, in soil containing 15% moisture content. Meanwhile, the solid N source (urea) was applied in three equal doses during the growing season 2016/2017 and 2017/2018. The first one was applied at planting, the second was applied before the first irrigation, where the last dose was applied before the second irrigation.

Potassium was applied as potassium sulphate 48% K_2O and phosphorus as calcium superphosphate 15.5% P_2O_5 at rates of 100 and 50 kg fed-1, respectively before sowing for all plots of the experimental soil.

The experiment was designed as a split–split-plot arrangement of treatments with three replications. Nitrogen application sources in the main plot; nitrogen fertilization levels were distributed randomly in the subplot and (without boron and boron) were located in the sub–sub plots with three replication. The experimental unit area was 10.5m2 (1/400fed) (one Fadden = 4200m^2). Seeds were sown on September 15 and 20 in the 2016 and 2017 seasons, respectively. The preceding summer crop was maize in both seasons.

The soils were analyzed for mechanical and some chemical properties according to **The mechanical analysis** was done according to **Piper (1950)**. **Total calcium carbonate** was determined according to **(Jackson, 1981). Soil organic matter** was determined according to the modified method of Walkley and Black, as described by **Jackson, (1973)**. **pH Soil** was measured in 1:2.5 soil water suspension **according to (Jackson, 1981)**

and EC_e was measured in saturated soil paste according to **(Jackson,1981) Soluble cations (Mg^{+2}, Ca^{+2}, Na^{+}, K^{+})** and soluble anions **(HCO_3^{-}, CO_3^{-2}, SO_4^{-2}, Cl^{-})** were determined in soil paste extract as described by **Page *et al*.,(1982). Available nitrogen content in soil (mg /kg)** was determined by the method described by **Jackson (1973). Available phosphorus** was extracted according to **Olsen *et al.* (1954).** and measured colourimetrically according to **Jackson (1967). Available potassium and sodium were** determined by flame photometrically as according to **Page *et al.* (1982). Boron content in the soil** was extracted using Hot Water according to **Berger and Truog (1939)** and determined by the Azmothine-H method according to **Bingham (1982).** Available zinc was determined by the method described by **Soltanpour and Workman (1979).**

2-1-Yield and yield component characters:

At 120 days, as well as 200 days of sugar beet cultivation, samples of five plants were randomly taken from the shoot as well as from the roots to estimate the content of both of them from N, K, Na, and B as well as to estimate the dry and fresh weight. At harvest (200 days after sowing) five plants were randomly chosen from the outer ridges of each sub-sub plot to estimate yield components characters as follows: 1 - Root length (cm).2 - Root diameter (cm). 3- shoot fresh weight (g /plant). 4- Root fresh weight (g/ plant). 5- shoot dry weight (g/plant).6- root dry weight (g/plant). Sucrose percentage (pol %) was polarimetically determined on a lead acetate extract of fresh macerated root according to the method of **Le- Docte (1927).**

At harvest, plants of all ridges from each sub-sub plot were harvested, cleaned, topped and weighed in addition to the weight of the five-plant sample.

2.2-Preparation of plant samples for analysis:

The plant part (leaves and roots) was weighed immediately after separation. Plant materials were cut into small portions, dried at 70º C for 24 hours in an aerated oven. After plant samples had become crisp, they were allowed to attain equilibrium with air for a few hours to establish reasonably stable moisture content before being weighed after being weighted. The crude dry materials were ground to pass a 60 mesh sieve in an agate ball-mill, and then thoroughly mixed, and a representative sample was stored in tightly stopper glass containers.

2.3-Plant analysis:

Representative portions of 0.5 g of the derived plant material were digested with the mixture of concentrated sulphuric and perchloric acids as described by **Page *et al.* (1982)**. Then, the extraction was diluted with distilled water to the volume of 50 ml in a calibration flask; this extraction was subjected to total N, K, Na, B and analysis as follow:

1- Total Nitrogen: Total nitrogen was determined Kjeldahl technique, **Jackson (1973)**.

2-Total potassium and sodium: was determined flame photometer as described by **Page *et al.* (1982)**.

3-Total Boron: Total Boron was Determined by wet digestion and determined by the **Azmothine-H** method according to **Bingham (1982).**

Uptake of N, K, Na and B were calculated by using multiplying the dry

weight with the respective percentage of N, K, Na and B nutrient uptake = nutrient concentration in the root or top X root or top dry weight

2.4-Statistical Analysis:

Results were statistically analyzed using COSTATC software. The ANOVA test was used to determine the significance ($p \leq 0.05$) treatment effect and the L.S.D Multiple Range Test was used to determine significantly the difference between individual means **Gomez and Gomez (1984)**.

3. RESULTS AND DISCUSSION

Average root fresh and dry weight (g), shoot fresh and dry weight (g), nitrogen uptake, potassium uptake, sodium uptake, and boron uptake in root and shoot of sugar beet at 120 days from sowing as affected by nitrogen sources, nitrogen rates and addition of boron and the effects of their interactions in 2016/2017 and 2017 /2018 seasons are shown in Tables 2-7. Results recorded in Tables 2 to 7 show clearly that all measured characters were significantly affected by nitrogen sources in both seasons. Sugar beet plants that received anhydrous ammonia gave the highest values of shoot fresh and dry weight 366.3 and 391.7 g, for fresh and 38.5,40.9 for dry respectively, root fresh and dry weight 480.3 and 523.1 for fresh and 99.4,102.8 g for dry. Nitrogen uptake by shoot and root 1450 and 1577 for the shoot, and 1995 and 2190 (mg/plant) for root, potassium uptake by shoot and root 1602,1595 for the shoot and 1575, 1553 (mg/plant) for root, sodium uptake by shoot and root 2243,2730 for the shoot and 1412,1417 (mg/plant) for root and boron uptake by shoot and root 1.98, 2.26 for the shoot and 1.45, 1.47 (mg/plant) for root .respectively. Meaning that the superiority of ammonia gaseous was achieved comparing with the other sources of nitrogen. The superiority of gaseous ammonia may be due to its noticed reduction in soil pH, which increased the availability of the nutrients and improved their efficiency uptake; therefore, the amount of dry matter was increased. This finding may be due to the great efficiency of gaseous ammonia as a source of nitrogen to fulfil the nitrogen needs of the plant. Similar results were obtained by **Ragab and Ibrahim (2009) and Seham (2012)**.

Results presented in Tables 2 to 7 show clearly that the effect of nitrogen rates was significant on all studied characters in both seasons. Sugar beet plants fertilized with a nitrogen fertilizer at the rate of 90 kg N/fed, gave the highest values of shoot fresh and dry weight 368.6,408.8 for fresh and 40.4,42.3 g for dry, respectively. root fresh and dry weight 482.6,540.5 for fresh and 98.9,102.0 g for dry, nitrogen uptake by shoot and root 1701,1726 for the shoot and 2255, 2228 (mg/plant) for root, potassium uptake by shoot and root 1767,1652 for the shoot and 1775, 1906 (mg/plant) for root, sodium uptake by shoot and root 2527, 2940 for the shoot and 1462, 1318 (mg/plant) for root and boron uptake by shoot and root 2.42, 2.48 for the shoot and 1.49,1.49 (mg/plant) for root, respectively. The increment of root fresh weight owing to raising nitrogen rate might be attributed to the active effect of nitrogen in increasing photosynthesis and net assimilation rate translocated and stored in roots which led to increasing

root length resulted in increasing root fresh weight. On the other hand, the increase in purity% caused by the lowest nitrogen rate may be due to the reduction in root length and root fresh weight resulted from smaller roots which have the lowest wetted, therefore Results tableted in Tables 2 to 7 show clearly that the effect of boron fertilization compared without boron was significant on all studied characters in both seasons. Sugar beet plants fertilized with boron gave the highest values of shoot fresh and dry weight 351.5, 364.8 for fresh and 36.6,38.1 g for dry, respectively. root fresh and dry weight 507.9,530.4 for fresh and 103.5,10.00 g for dry, nitrogen uptake by shoot and root 1489, 1518 for the shoot and 1862, 2064 (mg/plant) for root, potassium uptake by shoot and root 1499, 1403 for the shoot and 1454, 1494 (mg/plant) for root, sodium uptake by shoot and root 2320, 2559 for the shoot and 1664, 1595 (mg/plant) for root and boron uptake by shoot and root 2.10, 2.02 for the shoot and 1.52, 1.51 (mg/plant) for root, respectively. these results were in harmony with those obtained by **(Drycoot,2006)** found that boron in sugar beet is played an important role which it was involved in hemicellulose, lignin structural, cell elongation and division, tissue differentiation and metabolism of carbohydrate, protein, auxin, and phenol and in the end control of membrane permeability.

The obtained in the table from (2-7) showed that the interaction effect between nitrogen sources and nitrogen rates was significant on all studied characters except root fresh and dry weight (g) in the second season, shoot fresh weight (g) for the second season, nitrogen uptake for root in the first season, potassium uptake by root in the second season, sodium uptake by root in the first seasons did not significant. Results tabulated in Tables 2 to 7 exhibited that the interaction effect among nitrogen sources and micronutrients, nitrogen rates and micronutrients and nitrogen sources, nitrogen rates and micronutrients are not significant in both seasons.

Average root fresh and dry weight (g), shoot fresh and dry weight (g), nitrogen uptake, potassium uptake, sodium uptake, and boron uptake in root and shoot of sugar beet at harvest date as affected by nitrogen sources, nitrogen rates and addition of boron and their interactions in 2016/2017 and 2017/2018 seasons are shown in Tables 8-15. Results recorded in Tables 8 to 15 show clearly that all measured characters were significantly affected by nitrogen sources in both seasons. Sugar beet plants received anhydrous ammonia over urea by a percentage20.18 and 16.62 % of root fresh weight 22.14 and 18.03 %, for dry weight respectively, sucrose % 5.88 and 58.77 %, the yield of the sugar 24.39 and 23.06 % shoot fresh and dry weight (ton /fed) 28.02 and 29.59 % for shoot fresh weight and shoot dry weight (kg/fed) 26.37 and 30.36%, root length (cm) and volume (cm^3) 16.56 and 17.31% for root length and 22.99, 32.06% for root volume, (nitrogen uptake by shoot and root 16.98,13.54 % for nitrogen uptake by shoot and 15.32,16.30 % for nitrogen uptake by roots, potassium uptake by shoot and root 33.85,37.71% for the shoot and 22.46,18.35% for root, sodium uptake by shoot and root 32.74, 27.54% for the shoot and 22.51,18.52 for root and boron uptake by shoot and root 29.99,53.76% for the shoot and26.21,45.27 for the root, for the first and second season,

respectively. increased sucrose concentration thus increased purity%. These results are in agreement with those of, **Telep, *et al*. (2008), Abd EL-Motagally and Attia (2009), Manderscheid *et al*. (2010), and Gobarah Mirvat *et al*. (2011)**, who found that increasing N supply increased juice impurities such as Na content.

Table 2. Effect of nitrogen sources, rates, the addition of boron and their interaction on sugar beet shoot and root fresh weights (g/plant) after 120 days from sowing during 2016/ 2017 and 2017/2018 seasons.

Treatments		Shoot fresh weight (g/plant)						Root fresh weight (g/plant)					
Nitrogen source (S)	Nitrogen rate (R) (kg/fed.)	Season 2016/2017			Season 2017/2018			Season 2016/2017			Season 2017/2018		
		without	boron	Mean	without	boron	Mean	without	boron	Mean	without	boron	Mean
Anhydrous Ammonia	60	291.0	332.9	311.9	314.2	342.9	328.6	401.9	506.2	454.0	432.7	514.1	473.4
	75	340.5	392.4	366.5	378.8	410.9	394.8	410.1	519.8	465.0	479.4	547.0	513.2
	90	384.1	456.9	420.5	429.6	473.5	451.6	438.0	605.7	521.8	534.3	631.0	582.6
Mean		338.5	394.1	366.3	374.2	409.1	391.7	416.7	543.9	480.3	482.1	564.0	523.1
Urea	60	228.6	290.0	259.3	245.1	297.1	271.1	292.0	428.6	360.3	340.5	466.8	403.7
	75	272.5	302.7	287.6	273.4	320.2	296.8	337.5	458.4	398.0	378.6	491.7	435.2
	90	299.3	333.9	316.6	314.7	344.0	329.3	358.1	528.6	443.4	464.9	531.7	498.3
Mean		266.8	308.8	287.8	277.7	320.4	299.1	329.2	471.9	400.5	394.7	496.7	445.7
Means of nitrogen rates	60	259.8	311.4	285.6	279.7	320.0	299.8	346.9	467.4	407.2	386.6	490.4	438.6
	75	306.5	347.5	327.0	326.1	365.5	345.8	373.8	489.1	431.5	429.0	519.4	474.2
	90	341.7	395.4	368.6	372.1	408.8	390.5	398.1	567.1	482.6	499.6	581.4	540.5
Grand Mean		302.7	351.5	327.1	326.0	364.8	345.4	373.0	507.9	440.4	438.4	530.4	484.4
LSD 0.05													
Nitrogen source (S)			18.65			36.55			43.44			17.96	
Nitrogen rate (R)			17.17			26.11			20.33			4.40	
Micronutrients (M)			13.44			19.65			37.62			19.16	
S*R			24.28			N.S			N.S			6.23	
S*M			N.S			N.S			N.S			N.S	
R*M			N.S			N.S			N.S			N.S	
S*R*M			N.S			N.S			N.S			N.S	

Table 3. Effect of nitrogen sources, rates, the addition of boron and their interaction on sugar beet shoot and root dry weights (g/plant) after 120 days from sowing during 2016/ 2017 and 2017/2018 seasons.

Treatments		Shoot dry weight (g/plant)						Root dry weight (g/plant)					
		Season 2016/2017			Season 2017/2018			Season 2016/2017			Season 2017/2018		
Nitrogen source (S)	Nitrogen rate (R) (kg/fed.)	without	boron	Mean	without	boron	Mean	without	boron	Mean	without	boron	Mean
Anhydrous Ammonia	60	29.40	33.60	31.50	31.10	33.90	32.50	84.60	103.90	94.25	88.40	106.80	97.60
	75	34.70	40.00	37.35	39.80	43.10	41.45	90.70	108.90	99.80	92.70	114.10	103.40
	90	42.60	50.70	46.65	46.40	51.10	48.75	92.90	115.20	104.05	96.10	118.60	107.35
Mean		35.57	41.43	38.50	39.10	42.70	40.90	89.40	109.33	99.37	92.40	113.17	102.78
Urea	60	22.40	28.40	25.40	24.50	29.70	27.10	77.90	96.80	87.35	80.50	99.10	89.80
	75	27.70	30.90	29.30	28.40	33.30	30.85	86.00	98.30	92.15	86.70	102.50	94.60
	90	32.30	36.10	34.20	34.30	37.50	35.90	89.80	97.80	93.80	92.20	100.90	96.55
Mean		27.47	31.80	29.63	29.07	33.50	31.28	84.57	97.63	91.10	86.47	100.83	93.65
Means of nitrogen rates	60	25.90	31.00	28.45	27.80	31.80	29.80	81.25	100.35	90.80	84.45	102.95	93.70
	75	31.20	35.45	33.33	34.10	38.20	36.15	88.35	103.60	95.98	89.70	108.30	99.00
	90	37.45	43.40	40.43	40.35	44.30	42.33	91.35	106.50	98.93	94.15	109.75	101.95
Grand Mean		31.52	36.62	34.07	34.08	38.10	36.09	86.98	103.48	95.23	89.43	107.00	98.22
LSD 0.05													
Nitrogen source (S)			2.02			3.92			4.42			3.37	
Nitrogen rate (R)			1.79			2.76			3.95			0.91	
Micronutrients (M)			1.45			2.07			6.94			3.88	
S*R			2.53			3.91			N.S			1.28	
S*M			N.S			N.S			N.S			N.S	
R*M			N.S			N.S			N.S			N.S	
S*R*M			N.S			N.S			N.S			N.S	

Table 4. Effect of nitrogen sources, rates, the addition of boron and their interaction on N-uptake (mg/plant) sugar beet shoot and root after 120 days from sowing during 2016/ 2017 and 2017/2018 seasons.

Treatments		N- uptake by shoot (mg/plant)						N- uptake by root (mg/plant)					
		Season 2016/2017			Season 2017/2018			Season 2016/2017			Season 2017/2018		
Nitrogen source (S)	Nitrogen rate (R) (kg/fed.)	without	boron	Mean	without	boron	Mean	without	boron	Mean	without	boron	Mean
Anhydrous Ammonia	60	888	1255	1072	991	1319	1155	1860	1673	1766	1783	1808	1796
	75	1190	1539	1364	1314	1728	1521	2275	1800	2038	2222	2408	2315
	90	1626	2215	1921	1783	2325	2054	2423	1942	2182	2405	2511	2458
Mean		1229.6	1230	1670	1450	1363	1791	1577	2186	1805	1995	2137	2242
Urea	60	642	936	789	654	996	825	1809	1936	1872	1828	1895	1861
	75	878	1353	1116	966	1231	1098	2243	1756	2000	2226	2084	2155
	90	1327	1635	1481	1288	1506	1397	2588	2068	2328	2318	1678	1998
Mean		949.0	949	1308	1128	969	1244	1107	2213	1920	2067	2124	1886
Means of nitrogen rates	60	765	1095	930	823	1158	990	1834	1804	1819	1805	1851	1828
	75	1034	1446	1240	1140	1479	1310	2259	1778	2019	2224	2246	2235
	90	1477	1925	1701	1536	1916	1726	2506	2005	2255	2362	2095	2228
Grand Mean		1089.3	1089	1489	1289	1166	1518	1342	2200	1862	2031	2130	2064
LSD 0.05													
Nitrogen source (S)			227.24			266.43			56.38			65.15	
Nitrogen rate (R)			134.94			178.50			22.40			24.11	
Micronutrients (M)			88.06			152.05			83.37			N.S	
S*R			190.84			N.S			N.S			34.10	
S*M			N.S			N.S			N.S			120.56	
R*M			N.S			N.S			N.S			147.66	
S*R*M			N.S			N.S			N.S			N.S	

Table 5. Effect of nitrogen sources, rates, the addition of boron and their interaction on K-uptake (mg/plant) of sugar beet shoot and root dry weights after 120 days from sowing during 2016/ 2017 and 2017/2018 seasons.

Treatments		K- uptake by shoot (mg/plant)						K- uptake by root (mg/plant)					
Nitrogen source (S)	Nitrogen rate (R) (kg/fed.)	Season 2016/2017			Season 2017/2018			Season 2016/2017			Season 2017/2018		
		without	boron	Mean	without	boron	Mean	without	boron	Mean	without	boron	Mean
Anhydrous Ammonia	60	1035	1326	1181	955	1210	1083	1498	1141	1319	1467	1212	1340
	75	1335	1700	1517	1445	1708	1577	1761	1492	1626	1695	1426	1560
	90	196	2246	2108	1903	2348	2125	1881	1677	1779	1848	1671	1759
Mean		1446	1757	1602	1434	1755	1595	1713	1437	1575	1670	1436	1553
Urea	60	548	853	700	608	806	707	1513	1366	1439	1560	1319	1439
	75	862	1228	1045	829	1002	915	1781	1418	1599	1669	1449	1559
	90	1209	1643	1426	1017	1343	1180	1911	1630	1771	2217	1890	2053
Mean		873	1241	1057	818	1050	934	1735	1471	1603	1815	1553	1684
Means of nitrogen rates	60	792	1090	941	781	1008	895	1506	1253	1379	1514	1266	1389
	75	1098	1464	1281	1137	1355	1246	1771	1455	1613	1682	1437	160
	90	1589	1944	1767	1460	1845	1652	1896	1654	1775	2033	1780	1906
Grand Mean		1160	1499.2	1329	1126	1403	1264	1724	1454	1589	1743	1494	1619
LSD 0.05													
Nitrogen source (S)			160.60			296.31			39.90			36.89	
Nitrogen rate (R)			105.37			162.06			19.61			18.64	
Micronutrients (M)			122.17			89.19			67.18			65.40	
S*R			149.01			229.19			27.74			N.S	
S*M			N.S			N.S			N.S			N.S	
R*M			N.S			N.S			N.S			N.S	
S*R*M			N.S			N.S			N.S			N.S	

Table 6. Effect of nitrogen sources, rates, the addition of boron and their interaction on Na-uptake (mg/plant) of sugar beet shoot and root dry weights after 120 days from sowing during 2016/ 2017 and 2017/2018 seasons.

Treatments		Na- uptake by shoot (mg/plant)						Na- uptake by root (mg/plant)					
Nitrogen source (S)	Nitrogen rate (R) (kg/fed.)	Season 2016/2017			Season 2017/2018			Season 2016/2017			Season 2017/2018		
		without	Boron	Mean	without	boron	Mean	without	boron	Mean	without	boron	Mean
Anhydrous Ammonia	60	1338	2197	1767	1571	2032	1802	899	1646	1273	918	1698	1308
	75	1831	2298	2064	2956	2652	2804	1044	1768	1406	1028	1803	1415
	90	2484	3312	2898	3421	3744	3583	1179	1937	1558	1122	1932	1527
Mean		1884	2602	2243	2650	2810	2730	1041	1784	1412	1023	1811	1417
Urea	60	1049	1411	1230	1641	1894	1768	619	1337	978	671	1355	1013
	75	1105	2126	1615	1943	2466	2204	751	1560	1155	635	1412	1023
	90	1736	2576	2156	2032	2564	2298	997	1737	1367	850	1370	1110
Mean		1297	2038	1667	1872	2308	2090	789	1544	1167	719	1379	1049
Means of nitrogen rates	60	1194	1804	1499	1606	1963	1785	759	1492	1125	795	1526	1161
	75	1468	2212	1840	2450	2559	250	898	1664	1281	831	1607	1219
	90	2110	2944	2527	2727	3154	2940	1088	1837	1462	986	1651	1318
Grand Mean		1590	2320	1955	2261	2559	2410	915	1664	1289	871	1595	1233
LSD 0.05													
Nitrogen source (S)			339.97			317.97			140.93			370.89	
Nitrogen rate (R)			158.29			346.40			157.41			144.84	
Micronutrients (M)			216.41			190.79			160.44			176.40	
S*R			223.85			489.88			N.S			N.S	
S*M			N.S			N.S			N.S			N.S	
R*M			N.S			N.S			N.S			N.S	
S*R*M			N.S			N.S			N.S			N.S	

Table 7. Effect of nitrogen sources, rates, the addition of boron and their interaction on B-uptake (mg/plant) of sugar beet shoot and root dry weights after 120 days from sowing during 2016/ 2017 and 2017/2018 seasons.

Treatments		B- uptake by shoot (mg/plant)						B- uptake by root(mg/plant)					
Nitrogen source (S)	Nitrogen rate (R) (kg/fed.)	Season 2016/2017			Season 2017/2018			Season 2016/2017			Season 2017/2018		
		without	boron	Mean	without	boron	Mean	without	boron	Mean	without	boron	Mean
Anhydrous Ammonia	60	1.16	1.66	1.41	1.36	1.69	1.53	1.27	1.45	1.36	1.26	1.60	1.38
	75	1.55	2.09	1.82	1.80	2.28	2.04	1.34	1.60	1.47	1.33	1.59	1.46
	90	2.02	3.42	2.72	2.91	3.50	3.20	1.42	1.64	1.53	1.37	1.75	1.56
Mean		1.58	2.39	1.98	2.02	2.49	2.26	1.34	1.56	1.45	1.32	1.61	1.47
Urea	60	0.94	1.32	1.13	0.81	1.11	0.96	1.04	1.48	1.26	1.15	1.39	1.27
	75	1.26	1.70	1.48	1.07	1.66	1.36	1.17	1.36	1.26	1.27	1.39	1.33
	90	1.86	2.38	2.12	1.65	1.87	1.76	1.29	1.61	1.45	1.38	1.46	1.42
Mean		1.35	1.80	1.58	1.19	1.55	1.36	1.17	1.48	1.32	1.27	1.41	1.34
Means of nitrogen rates	60	1.05	1.49	1.27	1.08	1.40	1.24	1.15	1.47	1.31	1.21	1.44	1.33
	75	1.41	1.89	1.65	1.43	1.97	1.70	1.25	1.48	1.37	1.30	1.49	1.39
	90	1.94	2.90	2.42	2.28	2.68	2.48	1.36	1.62	1.49	1.37	1.60	1.49
Grand Mean		1.47	2.10	1.78	1.60	2.02	1.81	1.25	1.52	1.39	1.29	1.51	1.40
LSD 0.05													
Nitrogen source (S)			0.14			0.22			0.05			0.04	
Nitrogen rate (R)			0.11			0.17			0.01			0.01	
Micronutrients (M)			0.08			0.16			0.06			0.06	
S*R			0.16			0.24			1.84			1.88	
S*M			N.S			N.S			N.S			0.07	
R*M			N.S			N.S			0.10			N.S	
S*R*M			N.S			N.S			0.14			N.S	

Results tableted in Tables 2 to 7 show clearly that the effect of boron fertilization compared without boron was significant on all studied characters in both seasons. Sugar beet plants fertilized with boron gave the highest values of shoot fresh and dry weight 351.5, 364.8 for fresh and 36.6,38.1 g for dry, respectively. root fresh and dry weight 507.9,530.4 for fresh and 103.5,100.0 g for dry, nitrogen uptake by shoot and root 1489, 1518 for the shoot and 1862, 2064 (mg/plant) for root, potassium uptake by shoot and root 1499, 1403 for the shoot and 1454, 1494 (mg/plant) for root, sodium uptake by shoot and root 2320, 2559 for the shoot and 1664, 1595 (mg/plant) for root and boron uptake by shoot and root 2.10, 2.02 for the shoot and 1.52, 1.51 (mg/plant) for root,.respectively. these results were in harmony with those obtained by **(Drycoot,2006)** found that boron in sugar beet is played an important role which it was involved in hemicellulose, lignin structural, cell elongation and division, tissue differentiation and metabolism of carbohydrate, protein, auxin, and phenol and in the end control of membrane permeability.

The obtained in the table from (2-7) showed that the interaction effect between nitrogen sources and nitrogen rates was significant on all studied characters except root fresh and dry weight (g) in the second season, shoot fresh weight (g) for the second season, nitrogen uptake for root in the first season, potassium uptake by root in the second season, sodium uptake by root in the first seasons did not significant.

Results tabulated in Tables 2 to 7 exhibited that the interaction effect among nitrogen sources and micronutrients, nitrogen rates and micronutrients and nitrogen sources, nitrogen rates and

micronutrients are not significant in both seasons.

Average root fresh and dry weight (g), shoot fresh and dry weight (g), nitrogen uptake, potassium uptake, sodium uptake, and boron uptake in root and shoot of sugar beet at harvest date as affected by nitrogen sources, nitrogen rates and addition of boron and their interactions in 2016/2017 and 2017/2018 seasons are shown in Tables 8-15. Results recorded in Tables 8 to 15 show clearly that all measured characters were significantly affected by nitrogen sources in both seasons. Sugar beet plants received anhydrous ammonia over urea by a percentage20.18 and 16.62 % of root fresh weight 22.14 and 18.03 %, for dry weight respectively, sucrose % 5.88 and 58.77 %, the yield of the sugar 24.39 and 23.06 % shoot fresh and dry weight (ton /fed) 28.02 and 29.59 % for shoot fresh weight and shoot dry weight (kg/fed) 26.37 and 30.36%, root length (cm) and volume (cm^3) 16.56 and 17.31% for root length and 22.99, 32.06% for root volume, (nitrogen uptake by shoot and root 16.98,13.54 % for nitrogen uptake by shoot and 15.32,16.30 % for nitrogen uptake by roots, potassium uptake by shoot and root 33.85,37.71% for the shoot and 22.46,18.35% for root, sodium uptake by shoot and root 32.74, 27.54% for the shoot and 22.51,18.52 % for root and boron uptake by shoot and root 29.99,53.76% for the shoot and26.21,45.27 for the root, for the first and second season, respectively. and These results may be due to that nitrogen has a vital role in building up metabolites, activating enzymes and carbohydrates accumulation which transferred from leaves to developing roots which in turn enhanced root length, diameter, and the fresh weight finally roots yield per unit area. Similar findings were reported by **Ramadan *et al*. (2003) and ElHassanin *et al*. (2016) and Abbas *et al* (2018).**

Results presented in Tables 8 to 15 show clearly that the effect of nitrogen rates was significant on all studied characters in both seasons. Adding 60 kg N/fed as nitrogen rate gave the lowest values from 75 and 90 kg N/fed for all characters such as root fresh and dry weight 10.95,19.91% and 9.34,18.91% for fresh root and 9.09,19.56 and 9.06,20.21 for dry root first and second season, respectively. yield of the sugar 2.54,5.71% and 1.50,4.79% first and second season, respectively, shoot fresh and dry weight (ton /fed) 12.43,21.99 and 6.26,18.26 % for shoot fresh weight and for shoot dry weight (kg/fed) 7.66,19.30 and 11.49,21.10% first and second season, respectively, root length (cm) and volume (cm^3) 10.30,28.37 and 15.88,23.99 % for root length and 18.61,43.20 and 25.96,45.86 % for root volume first and second season, respectively, (nitrogen uptake by shoot and root 14.31,30.36 and12.37,26.62 % for nitrogen uptake by shoot and 12.37,37.60 and 11.37,33.76 % for nitrogen uptake by roots, potassium uptake by shoot and root 10.63,24.67 and 14.31,31.74% for the shoot and 9.68,21.11 and 9.53,21.08% for root, sodium uptake by shoot and root 2.73,5.38 and 3.19,6.30 % for the shoot and 9.97,21.85 and 9.83,21.57% for root and boron uptake by shoot and root 35.78,66.06 and 39.79,116.52% for the shoot and 32.44,58.26 and30.06,103.80 for the root, for the first and second season, respectively. this is maybe attributed by the increment of growth attributes gained by increasing nitrogen

fertilizer level may be due to the role of nitrogen in developing root dimensions by increasing division or elongation of cells and also enhancing leaf initiation and increment chlorophyll concentration in leaves and photosynthesis process. This was associated with the accumulation of carbohydrates translocated from leaves to develop roots, consequently increasing root size The aforementioned findings are in agreement with those of **Attia *et al*. (2004) NemeatAlla(2005), Gomaa *et al*. (2005) and Awad-Allah *et al*. (2007).**
And sucrose % was increased from 90 kg N/fed to 60 kg N/fed and the 2.33,5.95 and 3.31,7.59 for the first and second season, respectively. **Weeden (2000)** explained that with an increase of nitrogen in the soil, the amino acid in root increases that it causes sugar crystallization and so decreasing of extractable sugar. And These results may be due to that nitrogen has a vital role in building up metabolites, activating enzymes and carbohydrates accumulation which transferred from leaves to developing roots which in turn enhanced root length, diameter, and the fresh weight finally roots yield per unit area. Similar findings were reported by **Ramadan e*t al*. (2003) and ElHassanin *et al*. (2016) and Abbas *et al* (2018).**

Results tableted in Tables 8 to 15 show clearly that the effect of boron fertilization compared without boron was significant on all studied characters in both seasons. Sugar beet plants fertilized with boron gave the highest values of root fresh and dry weight 13.44, 13.29% for fresh compared by without boron 15.12, 15.47. for the first and second season, respectively, sucrose % and the yield of the sugar (ton/fed) 8.77 ,11.02 % and the yield of the sugar (ton/fed) 20.50 ,23.06 % for the first and second season, respectively, shoot fresh and dry weight 30.77 ,22.54 % for fresh and 22.77 , 17.95 % for dry for the first and second season, respectively, root length (cm) and root volume(cm^3) 20.25 ,19.11% for the root length and 40.58 , 33.69% for the root volume for the first and second season, respectively, nitrogen uptake by shoot and root 19.20,19.54 % for the shoot and 14.60, 14.56 % for root for the first and second season, respectively, potassium uptake by shoot and root 22.97, 23.76 % for the shoot and 15.56 16.01 % for root for the first and second season, respectively, sodium uptake by shoot and root 5.44, 4.92 % for the shoot and 15.88 ,16.32% for root for the first and second season, respectively, and boron uptake by shoot and root 49.10 , 32.36 %% for the shoot and 42.40, 30.61% for the root for the first and second season, respectively This is due to the role of boron in translocation of be contain some essential micronutrients which the carbohydrate assimilated in the leaves, thus enhance stimulate the plant growth and production. Similar sugar accumulation in the roots. **Knany *et al* (2009). and Mekdad and Shaabab (2020)** concluded that, the application of boron which may be attributed to decrease uptake of impurities such as Na, K and alpha-amino-N in root juice, and **Seham *et al* (2015)**. and These are may attribute the increase in uptake might be due to transpiration loss which was more from leaves and resulted in more movement of applied boron with water in the xylem to the leaves but due to phloem immobility of boron, there was more accumulation of boron in the leaves. This was in confirmation with the results of **Zhao and Oosterhuuis (2003) and**

Nadian *et al* (2010). Al-Mohmmad and Al- Geddawi (2001) showed that boron consumption in sugar beet significantly increased the sugar yield due to increased glucose levels in root and phloem sap.

The obtained in the table from (8-15) showed that the interaction effect between nitrogen sources and nitrogen rates were not significant on all studied characters except sucrose % in the first season, the yield of the sugar second season, dry weight of shoot dry weight for first and second seasons, root volume for the first season, nitrogen uptake for the shoot in both seasons and nitrogen uptake root in the first season, potassium uptake by a shoot in both seasons, sodium uptake by a shoot in the first seasons and boron uptake by shoot and root in both seasons were significant.

Results tabulated in Tables 8 to 15 exhibited that the interaction effect among nitrogen sources and micronutrients were not significant in studied characters except root volume in the first season, nitrogen uptake by a shoot in the first seasons, boron uptake by shoots in both seasons and boron uptake by root in the second season were significant.

Results tabulated in Tables 8 to 15 exhibited that the interaction effect among nitrogen rates and micronutrients were not significant in studied characters except root length in the first season, nitrogen uptake by a shoot in both seasons and nitrogen uptake by root in the first season, potassium uptake by a shoot in the first season and boron uptake by a shoot in the first season and boron uptake by root in both season were significant.

Results tabulated in Tables 8 to 15 exhibited that the interaction effect among nitrogen sources, nitrogen rates and micronutrients are not significant in all studied characters except the weight of fresh root the second season, root volume in the first seasons, nitrogen uptake by a shoot in the first season, potassium uptake by a shoot in the second season and boron uptake by shoot and root in both seasons.

Table 8. Effect of nitrogen sources, rates, the addition of boron and their interaction on sugar beet fresh roots fresh and dry roots weights (ton/fed) at harvest time during 2016/ 2017 and 2017/2018 seasons.

Treatments		Weight of fresh root (ton/fed)						Weight of dry roots (ton/fed)					
Nitrogen source (S)	Nitrogen rate (R) (kg/fed.)	Season 2016/2017			Season 2017/2018			Season 2016/2017			Season 2017/2018		
		without	boron	Mean	without	boron	Mean	without	boron	Mean	without	boron	Mean
Anhydrous Ammonia	60	21.41	24.48	22.95	22.51	24.82	23.67	3.88	4.40	4.14	4.02	4.58	4.30
	75	23.89	26.82	25.36	24.03	26.96	25.50	4.08	4.69	4.39	4.22	4.84	4.53
	90	26.69	28.61	27.65	26.11	30.45	28.28	4.63	5.13	4.88	4.66	5.62	5.14
Mean		24.00	26.64	25.32	24.22	27.41	25.81	4.20	4.74	4.47	4.30	5.01	4.66
Urea	60	16.23	20.45	18.34	17.38	21.79	19.59	2.82	3.40	3.11	3.10	3.74	3.42
	75	18.62	22.25	20.44	19.95	23.65	21.80	3.18	3.89	3.54	3.51	4.25	3.88
	90	19.88	23.81	21.85	21.88	24.44	23.16	3.33	4.28	3.81	3.78	4.51	4.15
Mean		18.24	22.17	20.21	19.74	23.29	21.52	3.11	3.86	3.48	3.46	4.17	3.82
Means of nitrogen rates	60	18.82	22.47	20.64	19.95	23.31	21.63	3.35	3.90	3.63	3.56	4.16	3.86
	75	21.26	24.54	22.90	21.99	25.31	23.65	3.63	4.29	3.96	3.87	4.55	4.21
	90	23.29	26.21	24.75	24.00	27.45	25.72	3.98	4.71	4.34	4.22	5.07	4.64
Grand Mean		21.12	24.40	22.76	21.98	25.35	23.66	3.65	4.30	3.98	3.88	4.59	4.24
LSD 0.05													
Nitrogen source (S)			2.07			0.82			0.40			0.20	
Nitrogen rate (R)			1.41			1.05			0.24			0.28	
Micronutrients (M)			0.89			0.57			0.19			0.16	
S*R			N.S			N.S			N.S			N.S	
S*M			N.S			N.S			N.S			N.S	
R*M			N.S			N.S			N.S			N.S	
S*R*M			N.S			1.41			N.S			N.S	

Table 9. Effect of nitrogen sources, rates, the addition of boron and their interaction on Sucrose % and yield of sugar (ton/fed) sugar beetroot at harvest time during 2016/ 2017 and 2017/2018 seasons.

Treatments		Sucrose %						the yield of sugar (ton/fed)					
Nitrogen source (S)	Nitrogen rate (R) (kg/fed.)	Season 2016/2017			Season 2017/2018			Season 2016/2017			Season 2017/2018		
		without	boron	Mean	without	boron	Mean	without	boron	Mean	without	boron	Mean
Anhydrous Ammonia	60	17.20	18.70	17.95	17.43	19.10	18.27	3.27	3.94	3.61	3.33	4.11	3.72
	75	16.53	17.87	17.20	16.90	18.60	17.75	3.28	4.09	3.69	3.39	4.29	3.84
	90	15.63	17.13	16.38	16.23	17.73	16.98	3.42	4.13	3.78	3.49	4.55	4.02
Mean		16.45	17.90	17.18	16.85	18.48	17.67	3.32	4.05	3.69	3.40	4.32	3.86
Urea	60	15.20	17.50	16.35	15.60	18.00	16.80	2.37	3.03	2.70	2.60	3.33	2.97
	75	15.73	16.87	16.30	15.00	17.30	16.15	2.43	3.11	2.77	2.45	3.44	2.95
	90	15.17	16.57	15.87	14.27	16.57	15.42	2.45	3.33	2.89	2.54	3.43	2.99
Mean		15.37	16.98	16.17	14.96	17.29	16.12	2.42	3.16	2.79	2.53	3.40	2.97
Means of nitrogen rates	60	16.20	18.10	17.15	16.52	18.55	17.53	2.82	3.49	3.15	2.97	3.72	3.34
	75	16.13	17.37	16.75	15.95	17.95	16.95	2.86	3.60	3.23	2.92	3.87	3.39
	90	15.40	16.85	16.13	15.25	17.15	16.20	2.94	3.73	3.33	3.02	3.99	3.50
Grand Mean		15.91	17.44	16.68	15.91	17.88	16.89	2.87	3.61	3.24	2.97	3.86	3.41
LSD 0.05													
Nitrogen source (S)			0.56			0.60			0.09			0.15	
Nitrogen rate (R)			0.13			0.13			0.10			0.05	
Micronutrients (M)			0.65			0.66			0.09			0.06	
S*R			0.19			N.S			N.S			0.07	
S*M			N.S			N.S			N.S			N.S	
R*M			N.S			N.S			N.S			0.11	
S*R*M			N.S			N.S			N.S			N.S	

Table 10. Effect of nitrogen sources, rates, the addition of boron and their interaction on sugar beet shoot and root dry weights (Kg/plant) at harvest time days from sowing during 2016/ 2017 and 2017/2018 seasons.

Treatments		Shoot fresh weight (ton/fed)						Shoot dry weight (kg/fed)					
Nitrogen source (S)	Nitrogen rate (R) (kg/fed.)	Season 2016/2017			Season 2017/2018			Season 2016/2017			Season 2017/2018		
		without	boron	Mean	without	boron	Mean	without	boron	Mean	without	boron	Mean
Anhydrous Ammonia	60	5.16	7.11	6.14	6.07	6.93	6.50	534.94	645.35	590.15	550.25	647.33	598.79
	75	5.64	8.05	6.85	6.48	8.21	7.35	557.31	733.29	645.30	623.98	779.61	701.80
	90	6.24	8.45	7.35	7.46	8.67	8.07	627.95	812.36	720.16	727.96	825.35	776.66
Mean		5.68	7.87	6.78	6.67	7.94	7.30	573.40	730.33	651.87	634.06	750.76	692.41
Urea	60	3.28	5.37	4.33	4.01	5.99	5.00	388.86	507.79	448.33	404.83	516.59	460.71
	75	3.90	5.91	4.91	4.19	5.57	4.88	407.49	537.96	472.73	422.37	536.59	479.48
	90	4.39	6.42	5.41	4.39	6.69	5.54	442.61	594.92	518.77	446.99	565.91	506.45
Mean		3.86	5.90	4.88	4.20	6.08	5.14	412.99	546.89	479.94	424.73	539.70	482.21
Means of nitrogen rates	60	4.22	6.24	5.23	5.04	6.46	5.75	461.90	576.57	519.24	477.54	581.96	529.75
	75	4.77	6.98	5.88	5.34	6.89	6.11	482.40	635.63	559.01	523.18	658.10	590.64
	90	5.32	7.44	6.38	5.93	7.68	6.80	535.28	703.64	619.46	587.48	695.63	641.55
Grand Mean		4.77	6.89	5.83	5.43	7.01	6.22	493.19	638.61	565.90	529.40	645.23	587.31
LSD 0.05													
Nitrogen source (S)			0.69			0.54			25.23			28.07	
Nitrogen rate (R)			0.55			0.69			6.27			5.98	
Micronutrients (M)			0.38			0.56			22.60			23.83	
S*R			N.S			N.S			8.87			8.46	
S*M			N.S			N.S			N.S			N.S	
R*M			N.S			N.S			N.S			N.S	
S*R*M			N.S			N.S			N.S			N.S	

Table 11. Effect of nitrogen sources, rates, the addition of boron and their interaction on root length (cm) and root volume (cm^3) of sugar beet at harvest time during 2016/ 2017 and 2017/2018 seasons.

Treatments		Root length (cm)						Root volume (cm3)					
Nitrogen source (S)	Nitrogen rate (R) (kg/fed.)	Season 2016/2017			Season 2017/2018			Season 2016/2017			Season 2017/2018		
		without	boron	Mean	without	boron	Mean	without	boron	Mean	without	boron	Mean
Anhydrous Ammonia	60	22.86	26.84	24.85	22.13	28.90	25.52	716.00	1045.00	880.50	764.00	1345.00	1054.50
	75	24.14	30.17	27.16	26.57	32.97	29.77	780.00	1301.00	1040.50	1047.00	1616.00	1331.50
	90	27.98	34.35	31.17	28.75	35.03	31.89	967.00	1507.00	1237.00	1436.00	1767.00	1601.50
Mean		24.99	30.45	27.72	25.82	32.30	29.06	821.00	1284.33	1052.67	1082.33	1576.00	1329.17
Urea	60	17.99	22.40	20.20	18.47	24.23	21.35	496.00	833.00	664.50	548.00	945.00	746.50
	75	20.49	24.57	22.53	22.37	26.67	24.52	581.00	1003.00	792.00	732.00	1142.00	937.00
	90	21.90	31.41	26.66	24.15	28.28	26.22	627.00	1324.00	975.50	813.00	1238.00	1025.50
Mean		20.13	26.13	23.13	21.66	26.39	24.03	568.00	1053.33	810.67	697.67	1108.33	903.00
Means of nitrogen rates	60	20.43	24.62	22.52	20.30	26.57	23.43	606.00	939.00	772.50	656.00	1145.00	900.50
	75	22.32	27.37	24.84	24.47	29.82	27.15	680.50	1152.00	916.25	889.50	1379.00	1134.25
	90	24.94	32.88	28.91	26.45	31.66	29.05	797.00	1415.50	1106.25	1124.50	1502.50	1313.50
Grand Mean		22.56	28.29	25.43	23.74	29.35	26.54	694.50	1168.83	931.67	890.00	1342.17	1116.08
LSD 0.05													
Nitrogen source (S)			0.73			3.09			44.17			304.47	
Nitrogen rate (R)			1.51			1.60			15.25			144.42	
Micronutrients (M)			0.82			1.37			37.45			124.34	
S*R			N.S			N.S			21.57			N.S	
S*M			N.S			N.S			52.96			N.S	
R*M			1.42			N.S			N.S			N.S	
S*R*M			N.S			N.S			91.73			N.S	

Table 12. Effect of nitrogen sources, rates, the addition of boron and their interaction on sugar beet N- uptake by shoot and roots (kg/fed) at harvest time during 2016/ 2017 and 2017/2018 seasons.

Treatments		N- uptake by shoot (kg/fed)						N- uptake by root (kg/fed)					
Nitrogen source (S)	Nitrogen rate (R) (kg/fed.)	Season 2016/2017			Season 2017/2018			Season 2016/2017			Season 2017/2018		
		without	boron	Mean	without	boron	Mean	without	boron	Mean	without	boron	Mean
Anhydrous Ammonia	60	6.71	7.89	7.30	6.86	7.96	7.41	23.22	24.10	23.66	23.99	25.19	24.59
	75	7.73	9.58	8.66	7.64	9.13	8.39	25.12	29.15	27.14	26.03	29.88	27.96
	90	8.82	10.87	9.85	8.19	10.75	9.47	31.58	37.57	34.58	31.81	38.27	35.04
Mean		7.75	9.45	8.60	7.56	9.28	8.42	26.64	30.27	28.46	27.28	31.11	29.20
Urea	60	5.80	6.98	6.39	5.94	7.02	6.48	20.17	22.69	21.43	20.97	23.10	22.04
	75	6.03	7.98	7.01	6.33	8.13	7.23	21.18	25.91	23.55	21.57	26.35	23.96
	90	7.10	8.92	8.01	7.06	9.20	8.13	23.96	30.69	27.33	23.90	30.74	27.32
Mean		6.31	7.96	7.14	6.44	8.12	7.28	21.77	26.43	24.10	22.15	26.73	24.44
Means of nitrogen rates	60	6.26	7.44	6.85	6.40	7.49	6.95	21.70	23.40	22.55	22.48	24.15	23.31
	75	6.88	8.78	7.83	6.99	8.63	7.81	23.15	27.53	25.34	23.80	28.12	25.96
	90	7.96	9.90	8.93	7.63	9.98	8.80	27.77	34.13	30.95	27.86	34.51	31.18
Grand Mean		7.03	8.70	7.87	7.00	8.70	7.85	24.21	28.35	26.28	24.71	28.92	26.82
LSD 0.05													
Nitrogen source (S)			0.20			0.28			1.00			1.22	
Nitrogen rate (R)			0.09			0.08			0.27			2.69	
Micronutrients (M)			0.31			0.31			1.07			2.92	
S*R			0.13			0.11			0.39			N.S	
S*M			0.44			N.S			N.S			N.S	
R*M			0.54			0.53			1.85			N.S	
S*R*M			0.76			N.S			N.S			N.S	

Table 13. Effect of nitrogen sources, rates, the addition of boron and their interaction on K-uptake (kg/fed) of sugar beet shoot and root dry weights at harvest time during 2016/ 2017 and 2017/2018 seasons.

Treatments		K- uptake by shoot (kg/fed)						K- uptake by root (kg/fed)					
Nitrogen source (S)	Nitrogen rate (R) (kg/fed.)	Season 2016/2017			Season 2017/2018			Season 2016/2017			Season 2017/2018		
		without	boron	Mean	without	boron	Mean	without	boron	Mean	without	boron	Mean
Anhydrous Ammonia	60	7.82	10.35	9.09	8.53	11.54	10.03	52.00	59.27	55.64	54.63	62.57	58.60
	75	9.30	10.92	10.11	10.20	12.78	11.49	55.15	63.49	59.32	57.47	66.63	62.05
	90	10.24	12.90	11.57	11.94	13.58	12.76	62.83	70.25	66.54	63.56	77.29	70.43
Mean		9.12	11.39	10.25	10.22	12.63	11.43	56.66	64.34	60.50	58.55	68.83	63.69
Urea	60	5.38	6.91	6.15	4.92	6.90	5.91	37.77	45.92	41.84	41.95	50.80	46.38
	75	5.85	7.66	6.75	6.09	8.32	7.21	42.62	52.57	47.60	47.63	58.22	52.93
	90	5.89	8.97	7.43	6.46	10.02	8.24	44.89	58.15	51.52	51.62	61.78	56.70
Mean		5.71	7.85	6.78	5.82	8.41	7.12	41.76	52.21	46.99	47.07	56.93	52.00
Means of nitrogen rates	60	6.60	8.63	7.62	6.72	9.22	7.97	44.88	52.59	48.74	48.29	56.69	52.49
	75	7.57	9.29	8.43	8.14	10.55	9.35	48.89	58.03	53.46	52.55	62.42	57.49
	90	8.06	10.93	9.50	9.20	11.80	10.50	53.86	64.20	59.03	57.59	69.54	63.56
Grand Mean		7.41	9.62	8.51	8.02	10.52	9.27	49.21	58.28	53.74	52.81	62.88	57.85
LSD 0.05													
Nitrogen source (S)			0.41			0.50			5.77			2.98	
Nitrogen rate (R)			0.09			0.10			3.24			4.17	
Micronutrients (M)			0.34			0.38			2.68			2.30	
S*R			0.48			0.13			N.S			N.S	
S*M			N.S			N.S			N.S			N.S	
R*M			0.59			N.S			N.S			N.S	
S*R*M			N.S			0.93			N.S			N.S	

Table 14. Effect of nitrogen sources, rates, the addition of boron and their interaction on sugar beet Na- uptake by shoot and roots (kg/fed) at harvest time during 2016/ 2017 and 2017/2018 seasons.

Treatments		Na- uptake by shoot (kg/fed)						Na- uptake by root (kg/fed)					
Nitrogen source (S)	Nitrogen rate (R) (kg/fed.)	Season 2016/2017			Season 2017/2018			Season 2016/2017			Season 2017/2018		
		without	boron	Mean	without	boron	Mean	without	boron	Mean	without	boron	Mean
Anhydrous Ammonia	60	12.90	13.55	13.23	12.60	12.85	12.73	32.99	37.73	35.36	34.93	40.10	37.52
	75	13.17	13.81	13.49	12.86	13.39	13.13	35.17	40.51	37.84	36.77	42.90	39.84
	90	13.34	14.05	13.70	13.04	13.90	13.47	40.13	45.10	42.62	40.72	49.77	45.25
Mean		13.14	13.80	13.47	12.83	13.38	13.11	36.10	41.11	38.61	37.47	44.26	40.87
Urea	60	8.56	8.85	8.71	8.94	9.45	9.20	23.98	29.23	26.61	26.74	32.50	29.62
	75	8.80	9.28	9.04	9.20	9.77	9.49	27.04	33.54	30.29	30.45	37.37	33.91
	90	8.95	9.91	9.43	9.47	10.18	9.83	28.56	37.19	32.88	33.10	39.66	36.38
Mean		8.77	9.35	9.06	9.20	9.80	9.50	26.53	33.32	29.92	30.10	36.51	33.30
Means of nitrogen rates	60	10.73	11.20	10.97	10.77	11.15	10.96	28.49	33.48	30.98	30.84	36.30	33.57
	75	10.99	11.55	11.27	11.03	11.58	11.31	31.11	37.03	34.07	33.61	40.14	36.87
	90	11.15	11.98	11.56	11.26	12.04	11.65	34.35	41.15	37.75	36.91	44.72	40.81
Grand Mean		10.95	11.58	11.26	11.02	11.59	11.30	31.31	37.22	34.26	33.79	40.38	37.08
LSD 0.05													
Nitrogen source (S)			0.52			0.49			3.85			1.99	
Nitrogen rate (R)			0.10			0.09			2.10			2.78	
Micronutrients (M)			0.45			0.45			1.75			1.52	
S*R			0.14			N.S			N.S			N.S	
S*M			N.S			N.S			N.S			N.S	
R*M			N.S			N.S			N.S			N.S	
S*R*M			N.S			N.S			N.S			N.S	

Table 15. Effect of nitrogen sources, rates, the addition of boron and their interaction on sugar beet B- uptake by shoot and roots (g/fed) at harvest time during 2016/ 2017 and 2017/2018 seasons.

Treatments		B-uptake by shoot (g/fed)						B- uptake by root (g/fed)					
Nitrogen source (S)	Nitrogen rate (R) (kg/fed.)	Season 2016/2017			Season 2017/2018			Season 2016/2017			Season 2017/2018		
		without	boron	Mean	without	boron	Mean	without	boron	Mean	without	boron	Mean
Anhydrous Ammonia	60	11.56	18.89	15.23	13.08	19.16	16.12	48.73	64.58	56.66	53.26	68.32	60.79
	75	13.72	23.78	18.75	15.84	25.34	20.59	50.44	75.53	62.99	53.38	79.46	66.42
	90	17.30	38.41	27.86	31.04	39.85	35.45	63.48	121.68	92.58	99.14	135.92	117.53
Mean		14.19	27.03	20.61	19.99	28.12	24.05	54.22	87.26	70.74	68.59	94.57	81.58
Urea	60	8.53	13.35	10.94	5.36	8.65	7.01	30.79	44.68	37.74	20.10	32.88	26.49
	75	10.38	23.14	16.76	7.42	16.04	11.73	40.56	83.52	62.04	30.93	63.26	47.10
	90	9.45	21.72	15.59	12.37	16.85	14.61	35.57	78.08	56.83	53.43	67.27	60.35
Mean		9.45	19.40	14.43	8.38	13.85	11.12	35.64	68.76	52.20	34.82	54.47	44.65
Means of nitrogen rates	60	10.05	16.12	13.08	9.22	13.91	11.56	39.76	54.63	47.20	36.68	50.60	43.64
	75	12.05	23.46	17.76	11.63	20.69	16.16	45.50	79.53	62.51	42.16	71.36	56.76
	90	13.38	30.07	21.72	21.71	28.35	25.03	49.53	99.88	74.70	76.29	101.60	88.94
Grand Mean		11.82	23.22	17.52	14.19	20.98	17.58	44.93	78.01	61.47	51.71	74.52	63.11
LSD 0.05													
Nitrogen source (S)			0.74			0.73			3.32			3.49	
Nitrogen rate (R)			0.39			0.18			7.24			1.12	
Micronutrients (M)			0.71			0.63			3.31			2.68	
S*R			0.55			0.26			10.24			1.58	
S*M			1.00			0.90			N.S			3.80	
R*M			1.23			N.S			5.74			4.65	
S*R*M			1.73			1.55			8.11			6.57	

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الملخص العربى

تأثير صور النيتروجين ومعدلاته والبورون على امتصاص عناصر النيتروجين والبوتاسيوم والصوديوم والبورون على جوده وانتاجية بنجر السكر

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تم إجراء تجربتين حقليتين بالمزرعة التجريبية التابعة لمركز البحوث الزراعية بمحطة بحوث طامية بمحافظة الفيوم. جمهورية مصر العربية خلال موسم الشتاء لعامين هما ٢٠١٧/٢٠١٦ و٢٠١٨/٢٠١٧. وذلك لدراسة التأثير المتبادل لإضافة مصدرين من النيتروجين (الأمونيا الغازية ٨٢٪ واليوريا ٤٦٪) في قطع التجربة الرئيسية، وتم استخدام ثلاثة معدلات نيتروجين (٦٠، ٧٥ ، ٩٠ كجم نتروجين / فدان) في قطع الأراضي التحت رئيسية، في حين تم استخدام مستويين من البورون (صفر، ١ جم/لتر) في القطع تحت تحت فرعية في تصميم قطع عشوائية منشقة مرتين وتأثير ذلك على جودة وبعض الصفات المحصولية والإنتاجية ومحتوى النبات من النيتروجين والبوتاسيوم والصوديوم والبورون عند عمر ١٢٠ يوم وكذلك عند عمر الحصاد على نبات بنجر السكر صنف (Gloria). و يمكن تلخيص النتائج الرئيسية على النحو التالي:

١- التسميد بالنيتروجين ينشط نمو النبات ويزيد من محصوله.
٢- أظهر مصدر النيتروجين مثل الأمونيا الغازية أعلى نمو وأعلى امتصاص من (N، K، Na، B) بينما أقل مصدر فعال كان اليوريا خلال ١٢٠ يوم وعند الحصاد.
٣- عن طريق زيادة معدل النيتروجين من ٦٠ إلى ٩٠ كجم / فدان أدى ذلك إلى زيادة محتوى الفروع والجذور من N وK وNa وB وكذلك زيادة عدد الاغصان و زيادة الوزن الطازج والجاف للجذور. تمت زيادة محصول السكر عند عمر ١٢٠ يوم من الزراعة وكذلك عند الحصاد، بينما أدى ذلك إلى انخفاض نسبة السكروز في الجذور عند الحصاد.
٤- تفوق إضافة البورون على عدم إضافته في جميع الصفات المدروسة مثل طول الجذر وحجمه والعناصر الممتصة مثل N وK وNa وB وكذلك نسبة السكر ومحصول السكر لكل فدان ووزن الجذور والأوراق في كلا الموسمين.

الكلمات الدلالية: بنجر السكر، الامونيا اللامائية، اليوريا، معدلات التسميد النيتروجيني، البورون، الجودة، الإنتاجية، ا لممتص من النيتروجين والبوتاسيوم والصوديوم والبورون.