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EFFECT OF IRRIGATION WATER QUANTITY, SOURCES AND RATES OF NITROGEN ON GROWTH AND QUALITY Of SUGAR BEET

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ABSTRACT

Two field experiments were carried out at Sakha Agric. Res. Station, Kafr El-Sheikh Governorate, Egypt during 2010/2011 and 2011/2012 seasons, to study the effect of three irrigation water quantity (3000, 2500 and 2000m^3), four nitrogen sources (Urea 46.5% N, Ammonium sulfate 20.6% N, Ammonium nitrate 33.5% N and Anhydrous ammonia 82% N) and three nitrogen rates (70, 80 and 90kg N/fed.) on growth yield and quality of sugar beet c.v. Gloriuf . The experiments were laid out in split plot design with four replications.

The obtained results indicated that decreasing amount of irrigation water from 3000m^3 to 2500 and 2000m^3 caused reduction in root fresh weight, α amino nitrogen and potassium% .On the other hand, reducing irrigation level from 3000m^3 to 2500 and 2000m^3 increased root length , sodium percentage as well as purity percentage .

Sugar beet plants received anhydrous ammonia gave the highest values of root length, root fresh weight , potassium and purity percentage , on the other hand, it gave the lowest values of α amino nitrogen and Sodium percentage.

Sugar beet plants fertilized with nitrogen fertilizer at the rate of 90kg N/fed. gave the highest values of root length , root fresh weight , potassium percentage and α amino nitrogen percentage, while the highest values of sodium percentage and purity percentage were recorded with plants received nitrogen fertilizer at the rate of 70kg N/fed. as compared with other nitrogen fertilizer rates .

At all irrigation levels nitrogen fertilizer application in the form of anhydrous ammonia gave the highest values of root length, root fresh weight, potassium% and purity%, but it gave the lowest values of α amino nitrogen% and sodium percentage .At the highest water regime (2000m^3/fed.) raising nitrogen fertilizer from 70 to 90kg N/fed. increased root length , root fresh weight , α amino nitrogen% and potassium% , on the contrary the highest Na and purity% were found with 70kg N/fed. At all nitrogen fertilizer rates plants received nitrogen in the form of anhydrous ammonia gave the highest values of root length, root fresh weight and purity%, on the other hand, this treatment gave the lowest values of α amino nitrogen % percentage and sodium percentage .

At the highest water regime (2000m^3/fed.) plants fertilized by nitrogen fertilizer at the rate of 90kg N/fed. in the form of anhydrous ammonia gave the longest root , heaviest roots, potassium percentage and purity percentage, on the contrary it gave the lowest α amino nitrogen percentage ,sodium percentage.

Generally, it could be concluded that when the shortage of irrigation water was presented, fertilizing sugar beet plants with nitrogen fertilizer in the form of anhydrous ammonia at the rate of 90kg N/fed. improved growth and root juice quality of sugar beet plants at Sakha Kafr El-Sheikh Governorate conditions.

INTRODUCTION

Sugar beet (*Beta vulgaris*, L.) ranks the second important sugar crop after sugar cane, producing annually 45% of sugar production all over the world. The Egyptian Government encourages sugar beet growers to increase the cultivated area for decreasing the gap between sugar production and consumption. This increase is likely to be obtained by increasing root and sugar production as well as decreasing sugar losses into molasses. The aim of sugar beet processors worldwide is to produce pure sugar at least expense from the roots which they have purchased and which represent their major manufacturing cost. The efficiency of processing depends on the root quality which is by far the most important parameter affecting processing. In order to understand the relationship between root quality and processing efficiency it is necessary to know the chemical constituents of beet root and raw juice. The significant of the amino acids as well as potassium and sodium has necessarily had to be taken into account in almost all calculation aimed at assessing the contribution of the non sugar to potential loss of sugar into molasses.

The quantity of water required to produce maximum root and sugar yields as well as juice quality are important as water stress limits plant growth and consequently reduce root yield and quality (Parashar *et al*., 1976). Ramazan *et al.* (2011) found that increasing water deficits resulted in a relatively lower white sugar yields.

Source of nitrogen application is important management tools in this respect because maximum nitrogen efficiency is obtained when nitrogen is applied in the form which is available for uptake by plant needed. Leilah *et al.* (2005), revealed that nitrogen fertilizer source as ammonium sulphate had significant effect on all growth parameters of sugar beet plants i.e. root length and fresh weight of roots compared to control. Nemeat-Alla (2009) and El-Sonbaty *et al*. (2012), declared that fertilizing sugar beet plants with urea (46% N) improved plant growth(length and fresh weight of root) compared to untreated plants.

Nitrogen is a major nutrient element and its needed in large amount for high yield of sugar beet and it considered the most factor affecting the growth and productivity of sugar beet. Tsialtas and Masalris (2005) showed that non sugar impurities (K, Na and alpha amino nitrogen) were positively related to the increasing nitrogen rate. El-Sarag (2009) and Nemeat, Alla (2009) found that increasing nitrogen up to 120kg N/fed increased root length and root fresh weight of sugar beet. Fathy and Attia (2009) reported that increasing nitrogen level up to 285kg N/ha increased impurities (Na, K and alpha amino nitrogen) in juice of sugar beet. Abd- El-kader (2011) found that average potassium and sodium % were significantly affected by nitrogen fertilizer rates .Increasing nitrogen fertilizer rate from 0 to 110kgN/fed. increased potassium % , on the other hand decreased sodium % .

The aim of the present investigation is to study the effect of irrigation water quantity, nitrogen sources and nitrogen rates on sugar beet growth and juice quality at Sakha, Kafr El-Sheikh Governorate conditions, Egypt.

MATERIALS AND METHODS

Two field experiments were carried out at Sakha Agricultural Research station, Kafr El-Sheikh Governorate, Egypt during 2010/2011 and 2011/2012 seasons, to study the effect of irrigation water quantity, nitrogen sources and rates on growth and juice quality of sugar beet, cv. Gloriuf.

Soil samples were randomly taken from the experimental sites at depth of 0 to 30cm from soil surface and were prepared for physical and chemical properties in 2010/2011 and 2011/2012 seasons according to Chapman and Pratt (1961). Physical and chemical properties of soil at the experimental sites in both seasons are shown in Table (1). The preceding summer crop was rice in both seasons.

The experiments treatments were as follows:

I-Irrigation water quantity

Three irrigation water quantity were applied as follows:

1. Applied 2000 m^3 water/fed.
2. Applied 2500 m^3 water/fed.
3. Applied 3000 m^3 water/fed.

All irrigation treatments were received the same sowing irrigation in both seasons. The irrigation water quantity were contained water amount of rainfall in both seasons as shown in Table (2). The irrigation treatments were started at 30 days from sowing.

Table 1: Physical and Chemical Properties of the experimental Soil:

Soil Properties		Season	
		2010/2011	2011/2012
A. Physical analysis (soil fraction)			
Sand %		19.5	17.9
Silt %		24.5	23.6
Clay %		56	58.5
Texture Class		Clay	Clay
Sp %		64	65
B. Chemical analysis			
PH (1 : 2.5)		7.9	8
EC (dS/m)		0.99	0.98
Ca CO_3 %		4	3.89
Soluble anions in extract			
HCO^-_3	(meq/L)	4	3.7
Cl	(meq/L)	2.54	3.38
$SO^{=}_4$	(meq/L)	3.42	2.79
Soluble cations in extract			
Na^+	(meg/L)	5	4.58
K^+	(meg/L)	0.4	0.57
Ca^{++}	(meg/L)	3.1	2.85
Mg^{++}	(meg/L)	1.46	1.7
Total N %		0.17	0.16
Available	N (ppm)	14	13
	P (ppm)	8.2	7.9
	K (ppm)	420	413

Table 2 : Quantity of seasonal irrigation water (IW) and rainfall water (R) applied to sugar beet in both seasons .

Irrigation regime (m^3 /fed.)	2010/2011 season		2011/2012 season	
	IW	R	IW	R
2000	1844.6	155.4	1470.5	529.5
2500	2344.6	155.4	1970.5	529.5
3000	2844.6	155.4	2470.5	529.5

II-Nitrogen sources

Four nitrogen sources studied were as follows:
1-Urea (46.5% N).
2-Ammonium sulphate (20.6% N).
3-Ammonium nitrate (33.5% N).
4-Anhydrous ammonia (82% N).

Anhydrous ammonia fertilizer (82% N) was injected into the soil at four days sowing using ammonia applicator device, while depth of injection was 20cm in soil containing 15% moisture content.

III- Nitrogen fertilizer rates

Three nitrogen rates were applied as follows:
1-Applied 70kg N/fed.
2-Applied 80kg N/fed.
3-Applied 90kg N/fed.

The three nitrogen rates from urea, ammonium sulfate and ammonium nitrate were added in two equal split doses, one at 45 days from sowing and the second at 75 days from sowing.

The experiments were carried out in split plot design with four replications. The irrigation treatments were randomly distributed in main plots, while nitrogen sources and rates were allocated at random in sub plots. The area of sub plot was $21m^2$ (7rows x 0.6m width x 5m length). Main plots (irrigation treatments) were isolated by ditches 1.5m in width to avoid lateral movement of water.

The experiment soil was prepared as usually and potassium as potassium sulphate 48% K_2O as well as phosphorus as superphosphate 15.5% P_2O_5 were added at the rate of 100kg fed^{-1} from both the two fertilizers before planting for all plots. Seeds were hand sown on 16 and 25 August in 2010/2011 and 2011/2012 seasons, respectively. Plants were thinned to one plants/hill after 35 days from sowing. Other cultural practices were done as recommended for sugar beet crop usually followed in the region.

The collected data in the experiment involved the following traits:

Data recorded

At harvest time five plants were chosen randomly from each sub -sub plot and the following traits were measured .
1-Root length (cm).
2-Root fresh weight (g).
3-Potassium percentage in juice .
4-Sodium percentage in juice .
5-Alpha amino nitrogen in juice .

6-Purity percentage .

Statistical Analysis

The analysis of variance was carried out according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Average root length (cm), root fresh weight (g), α amino nitrogen percentage, potassium percentage, sodium percentage and purity percentage in root juice of sugar beet as affected by irrigation water quantity, sources and rates of nitrogen fertilizer as well as their interactions in 2010/2011 and 2011/2012 seasons are shown in Tables 3-8.

Results recorded in Tables 3-8 indicate that the effect of irrigation water quantity was significant on all studied traits in both seasons. Decreasing amount of irrigation water from 3000m^3 to 2500 and 2000m^3 caused reduction in root fresh weight by 8.05 and 16.40%, α amino nitrogen by 0.37 and 0.67% as well as potassium percentage by 0.13 and 0.44% in 2010/2011 season, respectively, while in 2011/2012 season the corresponding values were 7.63 and 11.22%, 0.27 and 0.48% as well as 0.12 and 0.30% in the same respect. On the other hand, reducing irrigation level from 3000m^3 to 2500 and 2000m^3 increased root length by 6.79 and 15.13% as well as 8.50 and 16.58%, sodium percentage by 0.13 and 0.19% as well as 0.12 and 0.20% and purity percentage by 1.05 and 2.70% as well as 1.63 and 2.95% in 2010/2011 and 2011/2012 seasons, respectively. The reduction in root fresh weight caused by decreasing irrigation water level may be attributed to the deleterious effect of water deficit on cell elongation and division as well as cell number which led to produce the smaller root having the slight weight. On the contrary, the increase in purity% due to the lowest level of irrigation was might be attributed to the increase in sucrose% and k% as well as the reduction in α amino nitrogen percentage, thus impurities decreased and increasing purity% in root juice of sugar beet. These results are in harmony with those of Parashar *et al*. (1976) and Ramazan *et al.* (2011)

Results recorded in Tables 3 to 8 show clearly that all measured characters were significantly affected by nitrogen sources in both seasons.

Sugar beet plants received anhydrous ammonia gave the highest values of root length 35.3 and 32.62cm, root fresh weight 828.89 and 843.00g, potassium percentage 6.01 and 6.22% and purity percentage 83.53 and 84.81%. on the other hand, it gave the lowest values of α amino nitrogen percentage 1.55 and 1.50% and Sodium percentage 1.67 and 1.77% compared to all other nitrogen sources in 2010/2011 and 2011/2012 seasons, respectively. The superiority of anhydrous ammonia of growth and quality than other nitrogen sources may be due to it had maximum nitrogen efficiency and available for uptake by plants as well as it gave the highest values of growth traits and the lowest values of α amino N therefore, it gave the higher values of growth and juice purity% of sugar beet. These results are in harmony with those of Nemeat-Alla (2009) and El-Sonbaty *et al*. (2012).

Results presented in Tables 3 to 8 show clearly that the effect of nitrogen rates was significant on all studied characters in both seasons.

Sugar beet plants fertilized with nitrogen fertilizer at the rate of 90kg N/fed. gave the highest values of root length 32.46 and 30.48cm, root fresh weight 810.25 and 833.83g , α amino nitrogen percentage 1.99 and 1.85% and potassium percentage 6.23 and 6.33% , while the highest values of sodium percentage 1.88 and 2.01% and purity percentage 82.60 and 84.00% were recorded with plants received nitrogen fertilizer at the rate of 70kg N/fed. as compared with other nitrogen fertilizer rates in 2010/2011 and 2011/2012 seasons, 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 trans located 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 increased sucrose concentration, thus increased purity%. These results are in agreement with those of Fathy and Attia (2009) and Abd-El-kader (2011).

The obtained resulted show that the interaction effect between irrigation water amounts and nitrogen sources was significant on all studied characters in both seasons. At all irrigation levels nitrogen fertilizer application in the form of anhydrous ammonia gave the highest values of root length, root fresh weight and potassium%, but it gave the lowest values of α amino nitrogen% and sodium percentage as compared with all other interaction treatments in both seasons. However, at the lowest irrigation level (2000m^3/fed.) plants received anhydrous ammonia gave 7.56 and 5.17% increase in root fresh weight compared to Urea ,also it gave the highest purity % 85.60 and 87.10 % in 2010/2011 and 2011/2012 seasons, respectively.

Results tabulated in Tables 3 to 8 exhibited that the interaction effect among irrigation water quantity and nitrogen fertilizer rates significantly affected all measured studied in both seasons. At all irrigation levels, increasing nitrogen fertilizer rate significantly increased values of all studied traits in both seasons. At the highest water regime (2000m^3/fed.) raising nitrogen fertilizer from 70 to 90kg N/fed. increased root length by 10.61 and 12.91%, root fresh weight by 11.81 and 10.24%, α amino nitrogen% by 0.35 and 0.35% and potassium% by 0.67 and 0.53% as compared with other treatments in 2010/2011 and 2011/2012 seasons, respectively. The highest Na% 1.96 and 2.08% and purity% 83.95 and 85.20% were found with plants grown on the lowest irrigation level (2000m^3/fed.) and 70kg N/fed. fertilizer compared to all other interaction treatments in 2010/2011 and 2011/2012 seasons, respectively.

Results recorded in Tables 3-8 show that all studied traits significantly affected by the interaction between nitrogen sources and nitrogen rates in both seasons. At all nitrogen fertilizer rates plants received nitrogen in the form of anhydrous ammonia gave the highest values of root length, root fresh weight and purity%, on the other hand, this treatment gave the lowest values of α amino nitrogen acids percentage and sodium percentage compared to all other this interaction treatments in both seasons. The obtained results indicated that the interaction effect between irrigation levels, nitrogen sources and nitrogen rates was significant on all studied characters in both seasons. At the highest water regime (2000m^3/fed.) plants fertilizer by nitrogen fertilizer at the rate of 90kg N/fed. in the form of anhydrous ammonia gave the longest root 39.7 and 37.0cm, heaviest roots 820.00 and 860.09g and potassium percentage 6.11 and 6.35%, on the contrary it gave the lowest α amino nitrogen percentage 1.10 and 1.04% and sodium percentage 1.63 and 1.74% , while this treatment gave the highest purity % 86.20 and 88.10 % as compared with all other this interaction treatments in 2010/2011 and 2011/2012 seasons, respectively.

Generally, it could be concluded that when the shortage of irrigation water was presented, fertilizing sugar beet plants with nitrogen fertilizer in the form of anhydrous ammonia at the rate of 90kg N/fed. improved growth and root juice quality of sugar beet plants c.v.Gloriuf at Sakha Kafr El-Sheikh Governorate conditions.

Table 3 : Average root length (cm) of sugar beet as affected by irrigation regime, nitrogen sources, nitrogen rates and their interactions in 2010/2011 and 2011/2012 seasons.

Treatments		2010/2011 season				2011/2012 season			
		N-Rates (kg N/fed.$^{-1}$)				N-Rates (kg N/fed.$^{-1}$)			
Irrigation regime (m^{3}f^{-1})	**N-Sources**	**70**	**80**	**90**	**Mean**	**70**	**80**	**90**	**Mean**
3000	Urea	24.90	25.10	27.50	25.83	23.00	23.20	25.30	23.83
	Amm. Sulphate	23.90	24.40	28.20	25.50	22.00	23.40	26.30	23.90
	Ammonium nitrate	27.40	28.60	31.20	29.07	25.20	26.80	29.00	27.00
	Anhydrous Ammonia	31.70	32.00	34.60	32.77	29.40	29.50	31.80	30.23
Mean		**26.98**	**27.53**	**30.38**	**28.29**	**24.90**	**25.73**	**28.10**	**26.24**
2500	Urea	26.50	27.00	29.50	27.67	26.40	26.80	29.60	27.60
	Amm. Sulphate	25.50	26.00	30.00	27.17	23.50	24.90	27.80	25.40
	Ammonium nitrate	29.30	30.50	33.10	30.97	27.00	28.10	30.20	28.43
	Anhydrous Ammonia	34.00	34.10	37.00	35.03	31.20	31.50	34.60	32.43
Mean		**28.83**	**29.40**	**32.40**	**30.21**	**27.03**	**27.83**	**30.55**	**28.47**
2000	Urea	28.70	29.20	32.10	30.00	27.50	29.10	33.30	29.97
	Amm. Sulphate	28.00	28.10	31.20	29.10	25.00	25.90	28.60	26.50
	Ammonium nitrate	31.20	32.60	35.40	33.07	29.60	30.20	32.30	30.70
	Anhydrous Ammonia	37.20	37.40	39.70	38.10	34.10	34.80	37.00	35.20
Mean		**31.28**	**31.83**	**34.60**	**32.57**	**29.05**	**29.93**	**32.80**	**30.59**
Grand mean		**29.03**	**29.59**	**32.46**		**26.99**	**27.83**	**30.48**	
Means of N-sources	Urea	26.70	27.10	29.70	27.83	25.63	26.37	29.40	27.13
	Amm. Sulphate	25.80	26.17	29.80	27.26	23.50	24.73	27.57	25.27
	Ammonium nitrate	29.30	30.57	33.23	30.03	27.27	28.37	30.50	28.71
	Anhydrous Ammonia	34.30	34.50	37.10	35.30	31.57	31.83	34.47	32.62

LSD at 0.05:		
Irrigation	**1.53**	**1.75**
N-Sources	**2.15**	**2.25**
N- Rates	**1.87**	**1.99**
Irrigation x N-Sources	**2.25**	**2.51**
Irrigation x N-Rates	**1.43**	**2.18**
N-Sources x N-Rates	**2.01**	**1.87**

Table 4: Average root fresh weight (g) at harvest of sugar beet as affected by irrigation regime, nitrogen sources, nitrogen rates and their interactions in 2010/2011 and 2011/2012 seasons.

Treatments		2010/2011 season				2011/2012 season			
		N-Rates (kg N/fed.$^{-1}$)				N-Rates (kg N/fed.$^{-1}$)			
Irrigation regime (m^3f^{-1})	N-Sources	70	80	90	Mean	70	80	90	Mean
3000	Urea	770	847	880	832.33	810	833	893	845.33
	Amm. Sulphate	743	780	857	793.33	777	817	843	812.33
	Ammonium nitrate	753	880	863	832.00	787	827	870	828.00
	Anhydrous Ammonia	830	880	937	882.33	840	877	963	893.33
Mean		**774**	**846.75**	**884.25**	**835.00**	**803.50**	**838.50**	**892.25**	**844.75**
2500	Urea	737	763	807	769.00	767	787	817	790.33
	Amm. Sulphate	607	760	783	716.67	660	750	773	727.67
	Ammonium nitrate	736	750	790	758.67	753	773	817	781.00
	Anhydrous Ammonia	780	830	870	826.67	773	817	877	822.33
Mean		**715**	**775.75**	**812.50**	**767.75**	**738.25**	**781.75**	**821**	**780.33**
2000	Urea	683	723	763	723	770	787	763	773.33
	Amm. Sulphate	583	653	670	635.33	630	670	750	683.33
	Ammonium nitrate	630	656	683	656.33	683	727	780	730
	Anhydrous Ammonia	730	783	820	777.67	777	803	860	813.33
Mean		**656.50**	**703.75**	**734.00**	**698.08**	**715.00**	**746.75**	**788.25**	**750.00**
Grand mean		**715.17**	**775.42**	**810.25**		**752.25**	**789.00**	**833.83**	
Means of N-sources	Urea	730.00	777.67	816.67	774.78	782.33	802.33	824.33	803.00
	Amm. Sulphate	644.33	731.00	770.00	715.11	689.00	745.67	788.67	741.11
	Ammonium nitrate	706.33	762.00	778.67	749.00	741.00	775.67	822.33	780.00
	Anhydrous Ammonia	780.00	831.00	875.67	828.89	796.67	832.33	900.00	843.00

LSD at 0.05:		
Irrigation	**35.50**	**23.10**
N-Sources	**27.30**	**29.25**
N- Rates	**21.10**	**32.16**
Irrigation x N-Sources	**28.50**	**33.01**
Irrigation x N-Rates	**30.20**	**28.12**
N-Sources x N-Rates	**41.11**	**32.17**
Irrigation x N-Sources x N-Rates	**45.15**	**33.09**

Table 5: Average α amino nitrogen % in root juice of sugar beet as affected by irrigation regime, nitrogen sources, nitrogen rates and their interactions in 2010/2011 and 2011/2012 seasons.

Treatments		2010/2011 season				2011/2012 season			
		N-Rates (kg N/fed.$^{-1}$)				N-Rates (kg N/fed.$^{-1}$)			
Irrigation regime (m^3f^{-1})	N-Sources	70	80	90	Mean	70	80	90	Mean
3000	Urea	1.80	2.10	2.30	2.07	1.64	1.90	2.00	1.85
	Amm. Sulphate	1.91	2.13	2.45	2.16	1.75	2.01	2.15	1.97
	Ammonium nitrate	2.06	2.46	2.63	2.38	1.97	2.16	2.21	2.11
	Anhydrous Ammonia	1.71	2.02	2.06	1.93	1.52	1.89	1.95	1.79
Mean		**1.87**	**2.18**	**2.36**	**2.14**	**1.72**	**1.99**	**2.08**	**1.93**
2500	Urea	1.46	1.97	2.01	1.81	1.25	1.66	1.85	1.59
	Amm. Sulphate	1.69	1.75	1.89	1.78	1.49	1.63	1.81	1.64
	Ammonium nitrate	1.60	1.90	2.15	1.88	1.52	1.91	2.04	1.82
	Anhydrous Ammonia	1.35	1.60	1.83	1.59	1.46	1.50	1.76	1.57
Mean		**1.52**	**1.81**	**1.97**	**1.77**	**1.43**	**1.68**	**1.87**	**1.66**
2000	Urea	1.11	1.19	1.38	1.23	1.19	1.56	1.60	1.45
	Amm. Sulphate	1.50	1.66	1.90	1.69	1.41	1.52	1.73	1.55
	Ammonium nitrate	1.43	1.99	2.08	1.83	1.40	1.78	1.86	1.68
	Anhydrous Ammonia	1.10	1.15	1.18	1.14	1.04	1.12	1.24	1.13
Mean		**1.29**	**1.50**	**1.64**	**1.47**	**1.26**	**1.50**	**1.61**	**1.45**
Grand mean		**1.56**	**1.83**	**1.99**		**1.47**	**1.72**	**1.85**	
Means of N-sources	Urea	1.46	1.75	1.90	1.70	1.36	1.71	1.82	1.63
	Amm. Sulphate	1.70	1.85	2.08	1.88	1.55	1.72	1.90	1.72
	Ammonium nitrate	1.70	2.12	2.29	2.03	1.63	1.95	2.04	1.87
	Anhydrous Ammonia	1.39	1.59	1.69	1.55	1.34	1.50	1.65	1.50

LSD at 0.05:	2010/2011	2011/2012
Irrigation	0.25	0.20
N-Sources	0.14	0.10
N- Rates	0.13	0.11
Irrigation x N-Sources	0.10	0.07
Irrigation x N-Rates	0.13	0.10
N-Sources x N-Rates	0.09	0.10
Irrigation x N-Sources x N-Rates	0.13	0.11

Table 6: Average K % in roots of sugar beet as affected by irrigation regime, nitrogen sources, nitrogen rates and their interactions in 2010/2011 and 2011/2012 seasons.

Treatments		2010/2011 season				2011/2012 season			
		N-Rates (kg N/fed.$^{-1}$)				N-Rates (kg N/fed.$^{-1}$)			
Irrigation regime (m^3f^{-1})	N-Sources	70	80	90	Mean	70	80	90	Mean
3000	Urea	5.70	6.19	6.50	6.13	5.81	6.22	6.41	6.15
	Amm. Sulphate	5.75	5.91	6.20	5.95	5.96	6.00	6.23	6.06
	Ammonium nitrate	5.92	6.15	6.43	6.17	6.01	6.24	6.51	6.25
	Anhydrous Ammonia	5.80	6.20	6.55	6.18	6.15	6.29	6.68	6.37
Mean		**5.79**	**6.11**	**6.42**	**6.11**	**5.98**	**6.19**	**6.46**	**6.21**
2500	Urea	5.55	6.16	6.22	5.98	5.80	6.16	6.36	6.11
	Amm. Sulphate	5.58	5.85	6.20	5.88	5.69	5.95	6.17	5.94
	Ammonium nitrate	5.71	6.00	6.40	6.04	5.82	6.12	6.39	6.11
	Anhydrous Ammonia	5.59	6.15	6.32	6.02	5.95	6.17	6.50	6.21
Mean		**5.61**	**6.04**	**6.29**	**5.98**	**5.82**	**6.10**	**6.36**	**6.09**
2000	Urea	5.10	5.70	6.10	5.63	5.75	6.10	6.30	6.05
	Amm. Sulphate	5.33	5.76	6.04	5.71	5.61	5.80	6.12	5.84
	Ammonium nitrate	5.22	5.57	5.68	5.49	5.36	5.75	5.88	5.66
	Anhydrous Ammonia	5.57	5.81	6.11	5.83	5.80	6.12	6.35	6.09
Mean		**5.31**	**5.71**	**5.98**	**5.67**	**5.63**	**5.94**	**6.16**	**5.91**
Grand mean		**5.57**	**5.95**	**6.23**		**5.81**	**6.08**	**6.33**	
Means of N-sources	Urea	5.45	6.02	6.27	5.91	5.79	6.16	6.36	6.10
	Amm. Sulphate	5.55	5.84	6.15	5.85	5.75	5.92	6.17	5.95
	Ammonium nitrate	5.62	5.91	6.17	5.90	5.73	6.04	5.26	6.01
	Anhydrous Ammonia	5.65	6.05	6.33	6.01	5.97	6.19	6.51	6.22

LSD at 0.05:	2010/2011	2011/2012
Irrigation	0.11	0.10
N-Sources	0.04	0.05
N- Rates	0.17	0.13
Irrigation x N-Sources	0.05	0.03
Irrigation x N-Rates	0.19	0.16
N-Sources x N-Rates	0.21	0.22
Irrigation x N-Sources x N-Rates	0.05	0.06

Table 7: Average Na % in roots of sugar beet as affected by irrigation regime, nitrogen sources, nitrogen rates and their interactions in 2010/2011 and 2011/2012 seasons.

Treatments		2010/2011 season N-Rates (kg N/fed.$^{-1}$)				2011/2012 season N-Rates (kg N/fed.$^{-1}$)			
Irrigation regime (m^3f^{-1})	N-Sources	70	80	90	Mean	70	80	90	Mean
3000	Urea	1.80	1.72	1.53	1.68	1.84	1.75	1.61	1.73
	Amm. Sulphate	1.89	1.76	1.66	1.77	1.97	1.79	1.73	1.83
	Ammonium nitrate	1.86	1.80	1.72	1.79	2.08	1.92	1.81	1.94
	Anhydrous Ammonia	1.63	1.60	1.49	1.57	1.81	1.72	1.45	1.66
Mean		**1.80**	**1.72**	**1.60**	**1.70**	**1.93**	**1.80**	**1.65**	**1.79**
2500	Urea	1.89	1.88	1.87	1.88	1.94	1.92	1.79	1.88
	Amm. Sulphate	1.93	1.83	1.75	1.84	2.03	1.85	1.76	1.88
	Ammonium nitrate	1.94	1.86	1.94	1.91	2.18	2.07	1.96	2.07
	Anhydrous Ammonia	1.76	1.70	1.57	1.68	1.89	1.84	1.65	1.79
Mean		**1.88**	**1.82**	**1.78**	**1.83**	**2.01**	**1.92**	**1.79**	**1.91**
2000	Urea	1.98	1.96	1.90	1.95	2.02	1.99	1.84	1.95
	Amm. Sulphate	1.98	1.88	1.78	1.88	2.11	1.90	1.81	1.94
	Ammonium nitrate	2.06	1.95	1.89	1.97	2.23	2.15	1.99	2.12
	Anhydrous Ammonia	1.83	1.79	1.63	1.75	1.97	1.91	1.74	1.87
Mean		**1.96**	**1.90**	**1.80**	**1.89**	**2.08**	**1.99**	**1.85**	**1.97**
Grand mean		**1.88**	**1.81**	**1.73**		**2.01**	**1.90**	**1.76**	
Means of N-sources	Urea	1.89	1.85	1.77	1.84	1.93	1.89	1.75	1.85
	Amm. Sulphate	1.93	1.82	1.73	1.83	2.04	1.85	1.77	1.88
	Ammonium nitrate	1.95	1.87	1.85	1.89	2.16	2.05	1.92	2.04
	Anhydrous Ammonia	1.74	1.70	1.56	1.67	1.89	1.82	1.61	1.77

LSD at 0.05:	2010/2011	2011/2012
Irrigation	0.05	0.05
N-Sources	0.07	0.06
N- Rates	0.06	0.05
Irrigation x N-Sources	0.09	0.06
Irrigation x N-Rates	0.03	0.05
N-Sources x N-Rates	0.07	0.07
Irrigation x N-Sources x N-Rates	0.05	0.05

Table 8: Average purity% in root juice of sugar beet as affected by irrigation regime, nitrogen sources, nitrogen rates and their interactions in 2010/2011 and 2011/2012 seasons.

Treatments		2010/2011 season				2011/2012 season			
		N-Rates (kg N/fed.$^{-1}$)				N-Rates (kg N/fed.$^{-1}$)			
Irrigation regime (m^3f^{-1})	N-Sources	70	80	90	Mean	70	80	90	Mean
3000	Urea	83.90	81.70	80.30	81.97	85.30	82.80	81.20	83.10
	Amm. Sulphate	80.00	78.20	78.00	78.73	81.40	79.50	79.10	80.00
	Ammonium nitrate	79.30	78.90	78.20	78.80	80.90	80.00	79.10	80.00
	Anhydrous Ammonia	82.50	81.90	81.30	81.90	83.90	82.60	80.10	82.20
Mean		**81.43**	**80.18**	**79.45**	**80.35**	**82.88**	**81.23**	**79.88**	**81.33**
2500	Urea	84.90	83.10	82.70	83.57	86.10	84.20	83.80	84.70
	Amm. Sulphate	80.50	79.30	78.40	79.40	82.10	80.90	80.00	81.00
	Ammonium nitrate	80.10	79.50	79.00	79.53	81.50	80.90	80.60	81.00
	Anhydrous Ammonia	84.20	83.90	81.20	83.10	86.00	85.10	84.30	85.13
Mean		**82.43**	**81.45**	**80.33**	**81.40**	**83.93**	**82.78**	**82.18**	**82.96**
2000	Urea	86.00	85.10	84.10	85.10	87.30	86.30	85.60	86.40
	Amm. Sulphate	81.80	80.70	79.60	80.70	83.10	81.80	80.90	81.93
	Ammonium nitrate	81.80	80.60	80.20	80.87	82.30	81.70	81.10	81.70
	Anhydrous Ammonia	86.20	85.60	85.00	85.60	88.10	87.20	86.00	87.10
Mean		**83.95**	**83.00**	**82.23**	**83.06**	**85.20**	**84.25**	**83.40**	**84.28**
Grand mean		**82.60**	**81.54**	**80.67**		**84.00**	**82.75**	**81.82**	
Means of N-sources	Urea	84.93	83.30	82.37	83.50	86.23	84.43	83.53	84.73
	Amm. Sulphate	80.77	79.40	78.67	79.61	82.20	80.73	80.00	80.98
	Ammonium nitrate	80.40	79.67	79.13	79.73	81.57	80.87	80.27	80.90
	Anhydrous Ammonia	84.30	83.80	82.50	83.53	86.00	84.97	83.47	84.81

LSD at 0.05:	2010/2011	2011/2012
Irrigation	0.75	0.80
N-Sources	0.67	0.71
N- Rates	0.90	0.81
Irrigation x N-Sources	0.01	0.80
Irrigation x N-Rates	0.68	0.70
N-Sources x N-Rates	0.83	0.90
Irrigation x N-Sources x N-Rates	0.51	0.70

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تأثير كميات مياة الرى ومصادر ومعدلات النيتروجين على نمو وجودة محصول بنجر السكر

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اجريت تجربتان حقليتان بمحطة البحوث الزراعية بسخا بمحافظة كفر الشيخ مصر خلال موسمى ٢٠١١/٢٠١٠ ، ٢٠١٢/٢٠١١ لدراسة تأثير ثلاث كميات من مياه الرى (٢٠٠٠، ٢٥٠٠، ٣٠٠٠متر مكعب) و اربعة مصادر للنيتروجين (يوريا٤٦.٥% ن، سلفات الأمونيوم٢٠.٦% ن، ونترات الأمونيوم ٣٣.٥% ن، والامونيا الغازية ٨٢% ن) وثلاث معدلات للنيتروجين (٧٠- ٨٠- ٩٠ كيلوجرام نيتروجين/للفدان) على نمو وجودة بنجر السكر. صممت التجربة فى تصميم قطع منشقة مرة واحدة فى اربع مكررات.

اشارات النتائج المتحصل عليها أن نقص كمية مياه الرى من ٣٠٠٠متر مكعب الى ٢٥٠٠ متر مكعب، ٢٠٠٠ متر مكعب للفدان سببت نقصا معنويا فى صفة الوزن الغض للجذور وألفا امينو نيتروجين و النسبة المئوية للبوتاسيوم ومن الناحية الأخرى ادى خفض معدل الرى من ٣٠٠٠ متر مكعب الى ٢٥٠٠ متر مكعب ، ٢٠٠٠ متر مكعب الى زيادة طول الجذور والنسبة المئوية للصوديوم والنسبة المئوية للنقاوة.

اظهرت النتائج اختلافات معنوية بين مصادر النيتروجين وقد أعطت نباتات بنجر السكر التى سمدت بالأمونيا الغازية أعلى قيم لطول الجذور والوزن الغض للجذور والنسبة المئوية للبوتاسيوم والنقاوة. وعلى العكس من ذلك أعطت هذه النباتات أقل القيم للنسبة المئوية للفا امينو نيتروجين والنسبة المئوية للصوديوم.

ادت اضافة السماد النيتروجينى بمعدل ٩٠ كيلو جرام نيتروجين للفدان الى الحصول على اعلى قيم لطول الجذر والوزن الغض للجذور والنسبة المئوية للبوتاسيوم والنسبة المئوية لألفا امينو نيتروجين وبينما سجلت اعلى قيم للنسبة المئوية للصوديوم والنسبة المئوية للنقاوة مع النباتات المسمدة بمعدل ٧٠ كيلوجرام نيتروجين للفدان بالمقارنة مع المعدلات الأخرى.

عند كل معدلات الرى أعطت إضافة السماد النيتروجينى فى صورة أمونيا غازية أعلى قيم لطول الجذر والوزن الغض للجذر والنسبة المئوية للبوتاسيوم والنسبة المئوية للنقاوة ولكن أعطت أقل قيم للنسبة المئوية لالفا امينو نيتروجين والنسبة المئوية للصوديوم.

عند اقل كمية مياه للرى (٢٠٠٠ متر مكعب للفدان) ادت زيادة معدل السماد النيتروجينى من ٧٠ الى ٩٠ كيلوجرام نيتروجين للفدان الى زيادة طول الجذر والوزن الغض للجذور والنسبة المئوية لألفا امينو نيتروجين والنسبة المئوية للبوتاسيوم وعلى العكس أعلى نسبة مئوية للصوديوم والنقاوة وجدت عند استخدام ٧٠ كيلوجرام نيتروجين للفدان .

اعطت النباتات التى سمدت بالأمونيا الغازية أعلى قيم لكل من طول الجذر والوزن الغض للجذور والنسبة المئوية للنقاوة، ومن ناحية أخرى أعطت هذه المعاملة اقل قيم من النسبة المئوية لألفا امينو نيتروجين والنسبة المئوية للصوديوم مع اقل مستوى للرى(٢٠٠٠ متر مكعب للفدان). وكذلك عند اقل مستوى للرى (٢٠٠٠ م٣) سجلت النباتات المسمدة بمعدل ٩٠ كيلوجرام نيتروجين للفدان فى صورة أمونيا غازية أطول جذر وأثقل جذور واعلى نسبة مئوية للبوتاسيوم والنقاوة، وعلى العكس من ذلك أعطت أقل نسبة مئوية لألفا امينو نيتروجين وصوديوم.

عموما توصى الدراسة انه عند وجود نقص فى مياه الرى ادى تسميد نباتات بنجر السكر فى صورة أمونيا غازية عند معدل ٩٠ كيلوجرام نيتروجين للفدان الى تحسن النمو وجودة عصير الجذور فى نباتات بنجر السكر صنف Gloriuf تحت ظروف سخا محافظة كفر الشيخ.

قام بتحكيم البحث

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