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YIELD AND QUALITY OF SUGAR BEET AS AFFECTED BY ZINC FOLIAR APPLICATION UNDER DIFFERENT NITROGEN FERTILIZATION LEVELS

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ABSTRACT

Two field experiments were conducted in Sakha Research Station Kafr El-Sheikh Governorate during 2010 /2011 and 2011/2012 seasons to study the effect of the combination between three nitrogen levels (60 , 90 and 120 kg / fed) and four foliar zinc levels (0 , 0.5 , 1 and 1.5 g/ l as Zn-EDTA) on some physiological properties , yield and quality of sugar beet.

The obtained results proved that :

- The increase of N level up to 120 kg/ fed significantly increased root length and diameter as well as fresh weight/plant , leaf area , leaves zinc uptake , juice impurities content (K, Na and α-amino N) and yields of top and root (ton / fed) whereas , sucrose % , extractable sugar % , purity % and sugar yield were decreased in both seasons.
- The middle dose of nitrogen (90 kg N /fed) was the superior as compared with the highest dose (120 kg N/fed) on sucrose % , extractable sugar % , purity % and sugar yield as well as gave the lowest juice impurities content and sugar losses to molasses in both seasons .
- The increase of zinc level up to (1.5g/l) significantly increased all studied traits in both seasons except for N leaves content in the 1st season only as well as gave the lowest juice impurities content and sugar losses to molasses.
- Fertilization beet plant at the rate of 90 kg N/fed + 1.5 g Zn/l was enough to achieve the highest sugar yield (4.22 and 4.57 ton/fed) ,whereas the increase of N fertilization at the rate of 120 kg N / fed + 1.5 g Zn/l was necessary to attain the highest yields of top (10.01 and 10.78 ton/fed), and root (28.77 and 32.60 ton/fed) in the 1st and 2nd seasons respectively .

Therefore, it could be recommended that fertilization beet plant at the rate of 90 kg N/fed + 1.5 g Zn/l foliar application maximized sugar yield and technological parameters .

INTRODUCTION

Plant nutrition is one of the most important features in crops growth which greatly improved production and quality . In most regions of the world the use of chemical fertilizers is very unbalanced and is not based on plants requirement . Furthers, element in proper plant nutrition should be available enough for plants, balanced and not antagonistic (Alloway,2008) . In agricultural development programs role of micronutrients is very important to increase yield and quality . Therefore, the use of macrofertilizer such as nitrogen and micronutrients such as zinc , the following objectives can be achieved.

Nitrogen is an essential nutrient element for building up plants protoplasm , achieving higher growth , yield and best quality of field crops including sugar beet which controlled markedly by nitrogen fertilizer . Meantime, the reduction of N level significantly decreased both growth and yield, otherwise excess amount of nitrogen reduced most quality characteristics. Numerous studies indicated that sugar beet production of high yield and best quality adequate N supply was applied to develop an optimum canopy for photosynthesis and high juice quality (Moustafa *et al*. 2000 ; Azzazy , 2004 ; Moustafa *et al*. 2005 ; Osman , *et al*. 2010 ; Osman and Shehata , 2010 and Osman , 2011).

Zinc is one of the most important trace elements affected plant growth. The basic function of it is related to its role in the metabolism of carbohydrates, proteins and phosphates (Price *et al.,* 1972). Also, the essential role of Zn is in synthesis of tryptophane amino acid and consequently formation of auxins. i. e. IAA which act as growth regulator especially in prolonging height of plants (Devendra *et al*., 1999). In this respect Saif (1991) indicated that soil application of 4 kg Zn/fed gave significant increase in yields of tops, roots and sugar. El-Wan *et al*. (2001) found that Zn was more effective than Cu on total fresh and dry weights. Omran *et al*. (2002) reported that the most effective fertilization treatment was soil application of Zn (0.5%) companied with the highest rate of boric acid (0.10%) which promote the growth of sugar beet and gave the highest sucrose, sugar yield and extractable sugar. El-Gawad *et al*. (2004) indicated that there was a significant increase in N% in leaves due to application of a mixture containing 0.5 kg B +3 kg Zn +20g Mn /fed as compared with the check treatments. Yarnia *et al*. (2008) indicated that all three methods of applying micronutrients (Fe , Zn , B and Mn) resulted in higher leaf area index and net assimilation rate (NAR) and thus in higher sugar % and beet root yield. Osman (2011) found that foliar spray of micronutrient solution level at 1/2 L / fed attained a highest values of root diameter and fresh weight/plant as well as sucrose % , purity % root and sugar yields / fed. While N , Na and K % were decreased . Moustafa *et al*. (2011) indicated that foliar spray with Zn , Mn and Fe individually or in mixture significantly increased sucrose %, root length , diameter, fresh weight of roots , tops and sugar yield and increased the uptake of N, Zn , Mn and Fe.

Therefore, the aim of this work was to study the effect of zinc on yield and quality of sugar beet under different nitrogen levels.

MATERIALS AND METHODS

Two field experiments were carried out at Sakha Research Station, Kafr - El- Sheikh Governorate during the two growing seasons 2010 /2011 and 2011 /2012 to study the effect of the combination between three levels of nitrogen (60 , 90 and 120 kg N / fed) and four foliar zinc levels (0 , 0.5 , 1 and 1.5 g/ l as Zn-EDTA) on some physiological properties , yield and quality of sugar beet.

A multigerm sugar beet variety Farida was sown on 20 and 27 October in the 1st and 2nd seasons respectively. The plot area was 14 m^2 . Foliar application of Zn was applied after thinning .

A split plot design of three replication was used which nitrogen fertilizer occupied the main plot , whereas , zinc levels allocated in the sub plot .

Nitrogen fertilizer was added in the form of urea (46% N) in two equal doses , the first was applied after thinning (at 4 –true leaf stage) to have one plant per hill , while the second ones was added one month later. Phosphorus fertilizer was applied at the level of 30 Kg P_2O_5 as calcium super phosphate (15.5% P_2O_5) during seedbed preparation. Potassium fertilizer was added with the first dose of nitrogen at the level of 48 Kg K_2O /fed as potassium sulphate (48% K_2O). The normal agronomic practices in sugar beet fields are carried out as recommended by Sugar Crops Res. Inst., A.R.C. Chemical properties of the experimental site (Table 1) were determined according to Jackson (1973).

Table1:Soil mechanical and chemical analysis of experimental sites in Kafr El – Sheikh in both seasons.

Seasons	Mechanical analysis				
	Coarse sand %	Fine sand %	Silt %	Clay %	Soil texture
2010/2011	1.50	23.00	20.20	55.30	Clay
2011/2012	1.46	23.50	20.00	55.04	Clay

Seasons	Chemical analysis													
	Available nutrients (ppm)				pH 1:2.5	EC (ds/m)	Soluble anions (meq/l)				Soluble cations (meq/l)			
	Zn	N	P	K			Co3$^{=}$	Hco3^{-}	Cl^{-}	So4$^{=}$	Na^{+}	K^{+}	Ca^{++}	Mg^{++}
2010/2011	7.50	27.85	9.20	280.00	8.00	4.30	-	2.09	20.10	20.81	24.50	0.42	9.55	8.53
2011/2012	6.40	25.30	8.35	282.50	8.10	4.25	-	2.00	20.50	20.0	24.59	0.50	9.60	7.81

Recorded data :

At harvest (210 days after sowing) a sample of ten guarded sugar beet plants were taken from each plot to determine the following growth and juice characteristics :

1- Growth characters :

a – Root length (cm).
b – Root diameter (cm).
c - Root weight (kg).
d-Leaf area /plant (cm^2).

2- Leaves elemental uptake :

a-Leaf nitrogen content (%).
b-Leaf zinc content (ppm).

Leaves of sugar beet samples were dried , milled and wet digested for determination of N and Zn according to **(A.O.A.C.,1990).**

3- Juice quality and some technological parameters :

a – Sucrose % .
b– Impurities (Na , K and α- amino N meq/ 100 g beet).

The above parameters were determind in Delta Sugar Company Limeted Laboratories at El Hamoul Kafr El –Sheikh Governorate according to the method of McGinnus (1971).

c-Sugar loss to molasses (SLM %) was calculated according to Devillers (1988).

SLM % = 0.14 (Na +K) + 0.25 (α- amino N) + 0.5.
d- Extractable sugar (EX%) **.**
e-Purity%.

Extractable sugar (EXS %)and Purity % (P%) were calculated as proposed by **Dexter *et al* .(1967).**

Extractable sugar=sucrose% - (sugar loss to molasses%+0.6).
Purity %= 99.36 -(14. 27 (Na +K + α amino N)/sucrose%).

4- yield :

At harvest the following yields were carried out :
a – Top yield (ton / fed).
b – Root yield (ton / fed).
c– Sugar yield (ton/fed) was calculated according the following equation :

Sugar yield (ton/fed) = root yield (ton/fed) x extractable sugar % .

Statistical analysis :

The collected data were subjected to statistical analysis for the two seasons according to Snedecor and Cochran (1981). Treatment means were compared using LSD at 5% level of probability.

RESULTS AND DISCUSSION

1- Root characters :

Data presented in Table 2 showed that individual root performance in terms of root dimension i.e length, diameter and weight were significantly affected by nitrogen application in both seasons. Increasing N level up to 120 kg / fed enhanced root growth and hence increased root parameters. The primary effect of N fertilizer is on root and top dry matter production and stimulate water absorption (Milford and Watson , 1971). These results are in agreement with those obtained by Osman and Shehata (2010) and Osman (2011) they found that increasing N levels up to 120 kg/fed significantly increased length , diameter and weight of sugar beet root.

Regarding to the effect of zinc application, data showed that zinc application had a significant effect on root characteristics in both seasons as compared with control (Table 2). The highest level of Zn (1.5 g/l) recorded the highest averages values of these traits. Such effect may be due to the vital role of Zn in enhancement the vegetative growth and /or might be due to it is an essential constituent of carbonic enzyme. In addition, Zn has a marked effect on the level of auxin which appears to be required in the synthesis of intermediates in the metabolic pathway (Ohki , 1978) and in turn encourage the meristemic activity of the plant which reflected in more cell enlargement (Devlin and Witham 1983). These results are in the same trend with those obtained by Osman (2011) and Moustafa *et al*. (2011).

Root dimension (length ,diameter and weight) were not affected in any of the two seasons by the interaction between the two factors involved in this study indicating , thereby, that each factor affected this characters independently.

Table 2 : Effect of nitrogen fertilizations and zinc foliar application on root characteristics of sugar beet at harvest during 2010/2011 and 2011/2012 seasons.

Treatments		2010/2011			2011/2012		
Nitrogen (kg/fed)	Zinc levels	Length (cm)	Diameter (cm)	Fresh weight (kg)	Length (cm)	Diameter (cm)	Fresh weight (kg)
60	Control	26.50	9.50	0.773	28.70	10.50	0.810
	0.5 g/l	27.30	9.70	0.782	29.00	11.00	0.919
	l g/l	27.90	10.30	0.837	29.50	11.30	0.924
	1.5 g/l	28.50	10.80	0.931	30.60	11.50	1.000
Mean		**27.55**	**10.08**	**0.831**	**29.45**	**11.08**	**0.913**
90	Control	28.90	10.80	0.811	30.20	12.00	1.045
	0.5g/l	29.50	11.00	0.900	31.33	12.60	1.138
	l g/l	30.00	11.70	1.066	31.50	12.90	1.166
	1.5 g/l	30.30	12.20	1.136	32.00	13.40	1.220
Mean		**29.68**	**11.43**	**0.978**	**31.26**	**12.73**	**1.142**
120	Control	29.50	11.70	0.832	30.70	12.80	1.110
	0.5g/l	29.80	12.00	0.973	31.50	13.10	1.160
	l g/l	30.60	12.60	1.080	32.20	13.50	1.195
	1.5g/l	31.00	13.00	1.151	32.60	13.70	1.250
Mean		**30.23**	**12.33**	**1.009**	**31.75**	**13.28**	**1.179**
Means of Zinc	Control	28.30	10.67	0.805	29.87	11.77	0.988
	0.5g/l	28.87	10.90	0.885	30.61	12.23	1.072
	l g/l	29.50	11.53	0.994	31.07	12.57	1.095
	1.5g/l	29.93	12.00	1.073	31.73	12.87	1.157
LSD at 5%							
Nitrogen levels (A)		**0.23**	**0.43**	**0.037**	**0.93**	**0.52**	**0.085**
Zinc levels (B)		**0.51**	**0.27**	**0.073**	**0.72**	**0.32**	**0.036**
A x B		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

2- Effects on leaf area , nitrogen and zinc uptake :

2-a- Leaf area :

Data given in Table 3 revealed that increasing N fertilization level up to 120 kg/ fed significantly increased leaf area in both seasons. These results may be explained on the fact that N has a positive influences on photosynthesis process through its enhancement of leaf expansion and was reflected on yield . These results are in the same trend with those obtained by Moustafa *et al*. (2005).

As for , the effect of Zn foliar application , it could be noticed that increasing Zn level up to 1.5 g/l significantly increased leaf area in both seasons as compared with control (Table 3). These results are in line with those of Yarnia *et al*. (2008).

Table 3:Effect of nitrogen fertilizations and zinc foliar application on leaf area , nitrogen and zinc content of sugar beet leaves at harvest during 2010/2011 and 2011/2012 seasons.

Treatments		2010/2011			2011/2012		
Nitrogen (kg/fed)	**Zinc levels**	**Leaf area (cm)^2**	**Nitrogen (%)**	**Zinc (ppm)**	**Leaf area (cm)^2**	**Nitrogen (%)**	**Zinc (ppm)**
60	**Control**	125.5	3.50	13.5	140.2	3.67	14.0
	0.5 g/l	130.5	3.53	14.2	145.0	3.69	14.5
	I g/l	141.3	3.57	14.6	149.5	3.73	15.4
	1.5 **g/l**	148.2	3.58	15.0	154.6	3.75	15.8
Mean		**136.4**	**3.55**	**14.3**	**147.3**	**3.71**	**14.9**
90	**Control**	137.6	3.62	17.2	150.5	3.75	18.5
	0.5 g/l	145.0	3.66	19.5	161.2	3.77	20.3
	I g/l	155.3	3.70	21.8	170.9	3.81	22.5
	1.5 g/l	160.2	3.73	24.5	175.6	3.85	25.3
Mean		**149.5**	**3.68**	**20.8**	**164.6**	**3.80**	**21.7**
120	**Control**	145. 7	3.70	19.6	164.2	3.80	20.4
	0.5 g/l	156.1	3.72	22.0	168.4	3.84	23.2
	I g/l	165.9	3.78	23.5	177.3	3.86	24.9
	1.5 g/l	170.7	3.86	25.2	188.7	3.91	26.0
Mean		**159.6**	**3.77**	**22.6**	**174.7**	**3.85**	**23.6**
Means of Zinc	**Control**	136.3	3.61	16.8	151.6	3.74	17.6
	0.5 g/l	143.9	3.64	18.6	158.2	3.77	19.3
	I g/l	154.2	3.68	20.0	165.9	3.80	20.9
	1.5 g/l	159.7	3.72	21.6	171.6	3.84	22.4
LSD at 5%							
Nitrogen levels (A)		**1.00**	**0.05**	**0. 23**	**1.57**	**NS**	**0.15**
Zinc levels (B)		**1.84**	**0.06**	**0.48**	**1.63**	**NS**	**0.29**
A x B		**NS**	**NS**	**0.83**	**2.82**	**NS**	**0.49**

2-b- Leaves nitrogen and zinc uptake :

The obtained results in Table 3 cleared that , increasing N fertilizer up to 120 kg/ fed or Zn level up to 1.5 g/l have appositive effect on N (%) or Zn (ppm) content of beet leaves. These effects are significantly with respect to N content in the 1st season only and Zn content in both seasons. These effects may be due to that N dressing enhanced the uptake of minerals which finally reflected on better vegetative growth of plants .The same trend were reviewed by Moustafa *et al* .(2000 and 2011), El-Gawad *et al*.(2004) and Moustafa *et al* .(2005).

Concerning the interaction between N x Zn , data (Table 3) cleared that the interaction significantly affected leaf area in the 2nd season only and Zn content in both seasons. Otherwise, N not affected in both seasons.

Generally, fertilization beet plant at the rate of 120 Kg/fed +1.5g Zn/l gave the highest value of these traits.

3- Effects on non sugar component (juice impurities) :

Data given in Table 4 cleared that increasing N level up to 90 kg / fed significantly decreased K, Na and α-amino N in both seasons. In contrast , the three measured impurities increased as nitrogen dressing was increased up to 120 kg / fed. In general, K , Na and α- amino N are the serious impurities in beet juice and found much more than other elements. Moreover, these three elements not removed during beet processing but contribute to losses of sugar to molasses and hence effected greatly the extracted sugar. These findings are in agreement with those reported by Besheit *et al*. (1995) and Moustafa *et al*. (2011) they stated that Na, K and α- amino N were increased with the increase in N dressing.

Table 4 : Effect of nitrogen fertilizations and zinc foliar application on impurities content (meq /100gbeet) of sugar beet at harvest during 2010/2011 and 2011/2012 seasons.

Treatments		2010/2011			2011/2012		
Nitrogen (kg/fed)	**Zinc levels**	**Potassium**	**Sodium**	**α -amino nitrogen**	**Potassium**	**Sodium**	**α -amino nitrogen**
60	Control	3.65	1.75	1.34	5.88	2.89	2.00
	0.5 g/l	3.57	1.65	1.31	5.80	2.49	1.95
	1 g/l	3.54	1.59	1.27	5.78	1.93	1.67
	1.5 g/l	3.47	1.40	1.22	5.72	1.89	1.45
Mean		**3.56**	**1.60**	**1.29**	**5.80**	**2.30**	**1.77**
90	Control	3.60	1.47	1.22	5.83	2.03	1.98
	0.5 g/l	3.55	1.38	1.20	5.77	1.83	1.72
	I g/l	3.40	1.30	1.14	5.55	1.59	1.50
	1.5 g/l	3.36	1.25	1.10	5.51	1.39	1.25
Mean		**3.48**	**1.35**	**1.17**	**5.67**	**1.71**	**1.61**
120	Control	3.78	1.78	1.32	5.99	2.94	2.14
	0.5 g/l	3.70	1.69	1.28	5.98	2.65	2.13
	I g/l	3.65	1.63	1.23	5.95	2.56	1.99
	1.5 g/l	3.55	1.55	1.19	5.80	1.97	1.53
Mean		**3.67**	**1.66**	**1.26**	**5.93**	**2.53**	**1.95**
Means of Zinc	Control	3.68	1.67	1.29	5.90	2.62	2.04
	0.5 g/l	3.61	1.57	1.26	5.85	2.32	1.93
	I g/l	3.53	1.51	1.21	5.76	2.03	1.72
	1.5 g/l	3.46	1.40	1.17	5.68	1.75	1.41
LSD at 5%							
Nitrogen levels (A)		**0.02**	**0.04**	**0.02**	**0.05**	**0.03**	**0.04**
Zinc levels (B)		**0.04**	**0.02**	**0.03**	**0.03**	**0.02**	**0.05**
A x B		**NS**	**0.04**	**NS**	**0.06**	**0.04**	**0.09**

Dealing with the effect of Zn application , data (Table 4) cleared that Zn significant decrease juice impunities in both seasons as compared with control. It is worth to mentioned that the highest level of Zn (1.5 g/l) gave the lowest values of juice impurities content . In this connection , Moustafa *et al*. (2011) found that Zn , Fe and Mn individually or in mixture significantly decreased Na , while , K and α- amino N were increased as compared with (control).

Regarding to the interaction between N fertilizer levels and Zn levels, data (Table 4) exhibited a significant effect on juice Na content in both seasons as well as K and α -amino N in the 2nd season only.

Generally, fertilization beet plants with 90 kg N / fed + 1.5 g Zn/l as foliar application exhibited the lowest values of K (3.36 and 5.51), Na (1.25 and 1.39) and α amino nitrogen (1.1 and 1.25) in the1st and 2nd seasons respectively.

4-Effects on juice quality and technological parameters:

4-a- sugar losses to molasses :

Average data in Table 5 indicated that increasing N fertilizer up to 90 kg/ fed significantly decreased sugar losses to molasses % (SLM) in both seasons. Moreover, increase N dressing up to 120 kg/fed significantly increased this trait. These findings may be due to that the used middle dose of N (90 kg/fed) decreased markedly juice impurities, while , the highest dose of N (120 kg/fed) had a vice verse trend on these impurities as mentioned before. These results are in accordance with those of Moustafa *et al* .(2000) who found that increasing N levels up to 90 kg/fed minimized SLM % .

As for, the influence of Zn as foliar application on sugar lost to molasses (Table 5), it could be noticed that increasing Zn level up to 1.5g/l gradually and significantly decreased (SLM%) in both seasons as compared with control . Further, the highest level of Zn (1.5 g/l) gave the lowest value of this trait.

The interaction between N x Zn had insignificant effect in both seasons on this trait.

Table 5: Effect of nitrogen fertilizations and zinc foliar application on some technological parameters of sugar beet at harvest during 2010/2011 and 2011/2012 seasons.

Treatments		2010/2011				2011/2012			
Nitrogen (kg/fed)	Zinc levels	Sugar loss to molasses %	Sucrose %	Extractable sugar %	Purity %	Sugar loss to molasses %	Sucrose %	Extractable sugar %	Purity %
60	Control	1.59	15.95	13.76	93.35	2.23	15.87	13.04	89.68
	0.5g / l	1.55	16.00	13.85	93.69	2.15	15.90	13.15	90.17
	1 g/ l	1.53	16.22	14.09	93.76	2.00	16.19	13.59	91.09
	1.5g/l	1.48	16.30	14.22	94.05	1.93	16.23	13.70	91.39
Mean		**1.54**	**16.12**	**13.98**	**93.71**	**2.08**	**16.05**	**13.37**	**90.58**
90	Control	1.51	16.30	14.19	93.85	2.10	15.91	13.21	90.53
	0.5g / l	1.49	16.45	14.36	94.04	1.99	16.33	13.74	91.22
	1 g/ l	1.44	16.62	14.58	94.35	1.87	16.50	14.03	91.89
	1.5g/l	1.42	16.70	14.68	94.48	1.78	16.59	14.21	92.35
Mean		**1.47**	**16.52**	**14.45**	**94.18**	**1.94**	**16.33**	**13.80**	**91.50**
120	Control	1.61	16.25	14.04	93.30	2.29	15.88	12.99	89.41
	0.5g / l	1.58	16.33	14.15	93.51	2.24	16.21	13.37	89.89
	1 g/ l	1.56	16.55	14.39	93.71	2.19	16.32	13.53	90.18
	1.5g/l	1.52	16.57	14.45	93.92	1.97	16.40	13.83	91.27
Mean		**1.57**	**16.43**	**14.26**	**93.61**	**2.17**	**16.20**	**13.43**	**90.19**
Means of Zinc	Control	1.57	16.17	14.00	93.50	2.21	15.89	13.08	89.87
	0.5g / l	1.54	16.26	14.12	93.75	2.13	16.15	13.42	90.43
	1 g/ l	1.51	16.46	14.35	93.94	2.02	16.34	13.72	91.05
	1.5g/l	1.47	16.52	14.45	94.15	1.89	16.41	13.91	91.67
LSD at 5%									
Nitrogen levels (A)		**0.01**	**0.02**	**0.04**	**0.10**	**0.04**	**0.05**	**0.04**	**0.06**
Zinc levels (B)		**0.01**	**0.02**	**0.04**	**0.09**	**0.06**	**0.09**	**0.02**	**0.06**
A x B		**NS**	**0.03**	**NS**	**NS**	**NS**	**0.16**	**0.04**	**0.10**

4-b - Sucrose % , extracted sugar % and purity %:

Data in Table 5 indicated that increasing N level up to 9o kg/fed significantly increased juice quality in terms of sucrose% , extractable sugar and purity % in both seasons. On the other hand , increasing N level up to 120 kg/fed decreased juice quality. Such effects may be due to the favorable effect of the high N dressing on the vegetative growth rather than sugar accumulation. These findings are in harmony with those obtained by Moustafa *et al* .(2000) , Osman and Shehata (2010) and Osman (2011).

Regarding to the effect of Zn as foliar application. Data (Table 5) clarified that increasing Zn levels up to 1.5g/l significantly increased juice quality i.e sucrose , extractable sugar and purity in both seasons as compared with control to reach the highest level . These results are in line with those obtained by Omran *et al*. (2002) , Yarnia *et al*. (2008) and Osman (2011).

Concerning the interaction effect . Data (Table 5) affected significantly sucrose% in both seasons. Further, extractable sugar % and purity in the 1st season only.

Worth to mention that, fertilization beet plants with 90 kg N/fed + 1.5 g Zn/l as foliar application gave the highest values of sucrose % (16.7 and 16.59) , extractable sugar % (14.68 and 14.21) and purity % (94.48 and 92.35) in 1st and 2nd seasons respectively. Therefore N and Zn in the mentioned level were recommended to maximize beet root quality .

5- yields and its components :

Data given in Table 6 indicated that increasing N level up to 120 kg/fed significantly and gradually increased top, whereas, root yields under 90 and 120 Kg/ fed insignificantly differed in both seasons. Data also cleared that the middle dose of N (90 kg/ fed) was enough to achieve the highest value of sugar yield in both seasons. Meantime , increasing N up to 120 Kg/fed decreased sugar yield. These results are in agreement with those obtained by Osman *et al*. (2010), Osman and Shehata (2010) and Osman (2011) they found that increasing N level up to 120 kg/fed significantly increased root yield and decreased sugar yield .

With respect to the effect of Zn on yields , data (Table 6) showed that increasing Zn level up to 1.5 g/l significantly increased yields of top , root and sugar (ton /fed) in both seasons as compared with control. Sandman and Bogger (1983) indicated that yield increment might be due to the favorable influence of Zn on plant enzyme activity and improving the photosynthetic and mobilization in plants. Moreover, The pronounced effect of micronutrients is mainly due to their effect on growth hormone production which has a direct effect on plant growth , throughout their influence on the production of plant growth promoting substances and increase in various availability soil nutrients. These results are in the same trend with those obtained by Moustafa *et al*. (2011) and Osman (2011).

Concerning the interaction effect between N and Zn levels, data (Table 6) showed that the interaction significantly affected top , root and sugar yield in both seasons except for root yield in the 2nd season .

It could be concluded that , to maximize sugar yield as a final goal of beet cultivation , beet must fertilizer by 90 KgN/fed +1.5 g Zn/L as foliar application which achieving 4.22 and 4.57 ton sugar /fed in the 1st and 2nd seasons respectively.

Table 6 :Effect of nitrogen fertilizations and zinc foliar application on yield of sugar beet (ton/fed) at harvest during 2010/2011 and 2011/2012 seasons.

Treatments		2010/2011			2011/2012		
Nitrogen (kg/fed)	Zinc levels	Top yield	Root yield	Sugar yield	Top yield	Root yield	Sugar yield
60	Control	8.23	24.70	3.40	9.25	28.74	3.75
	0.5 g/l	8.35	25.31	3.51	9.71	29.13	3.83
	1 g/l	8.48	25.45	3.59	9.84	29.33	3.99
	1.5 g/l	8.58	26.64	3.79	10.34	29.81	4.08
Mean		**8.41**	**25.52**	**3.57**	**9.79**	**29.25**	**3.91**
90	Control	9.44	26.27	3.73	9.98	30.00	3.96
	0.5 g/l	9.54	26.54	3.81	10.10	31.79	4.37
	1 g/l	9.74	27.80	4.05	10.39	31.85	4.47
	1.5 g/l	9.99	28.72	4.22	10.53	32.19	4.57
Mean		**9.68**	**27.33**	**3.95**	**10.25**	**31.46**	**4.34**
120	Control	9.47	26.50	3.72	10.00	30.31	3.94
	0.5 g/l	9.56	26.76	3.79	10.24	31.81	4.25
	1 g/l	9.78	27.91	4.02	10.62	31.99	4.33
	1.5 g/l	10.01	28.77	4.18	10.78	32.60	4.51
Mean		**9.71**	**27.49**	**3.93**	**10.41**	**31.68**	**4.26**
Means of Zinc	Control	9.05	25.82	3.62	9.74	29.68	3.88
	0.5 g/l	9.15	26.20	3.70	10.02	30.91	4.15
	1 g/l	9.33	27.05	3.89	10.28	31.06	4.26
	1.5 g/l	9.53	28.04	4.06	10.55	31.53	4.39
LSD at 5%							
Nitrogen levels (A)		**0.02**	**0.47**	**0.04**	**0.04**	**0.38**	**0.02**
Zinc levels (B)		**0.02**	**024**	**0.03**	**0.05**	**0.53**	**0.02**
A x B		**0.04**	**0.42**	**0.05**	**0.10**	**NS**	**0.04**

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تأثير الرش بالزنك تحت مستويات مختلفة من التسميد النتروجيني على محصول وجودة بنجر السكر

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أجريت تجربتان حقليتان بمحطة بحوث سخا بكفر الشيخ خلال موسمي ٢٠١٠/٢٠١١ ، ٢٠١١ / ٢٠١٢ لدراسة تأثير التفاعل بين ثلاث مستويات للتسميد النيتروجيني (٦٠ ، ٩٠ ، ١٢٠ كجم نيتروجين / فدان) واربعة مستويات لعنصر الزنك (كنترول ، ٠.٥ ، ١ ، ١.٥ جم / لتر فى صورة زنك مخلبى) على بعض الصفات الفسيولوجية ومحصول وجودة بنجر السكر.

يمكن تلخيص النتائج كما يلي :

- أدى استخدام التسميد النيتروجيني بمعدل ١٢٠ كجم / فدان إلى زيادة معنوية في صفات طول وقطر ووزن الجذر/ نبات كذلك مساحة الأوراق ومحتواها من عنصر الزنك وايضا محتوى العصير من الشوائب (البوتاسيوم والصوديوم وألفا أمينونيتروجين) ومحصول العرش والجذور (طن / فدان) بينما انخفضت النسبة المئوية للسكروز والسكر المستخلص والنقاوة ومحصول السكر في كلا الموسمين.
- اتضح ان المعدل الأوسط من التسميد النيتروجيني(٩٠ كجم / فدان) كان متفوقا على المعدل المرتفع (١٢٠ كجم / فدان) فى النسبة المئوية للسكروز والسكر المستخلص والنقاوة ومحصول السكر كذلك أعطى أقل قيمة للشوائب وا لسكر المفقود في المولاس في كلا الموسمين.
- ادى الرش بالزنك المخلبي بمعدل ١.٥ جم / لتر الى زيادة معنوية فى جميع الصفات المختبرة في كلا الموسمين ما عدا محتوى الأوراق من النيتروجين حيث كان معنويا فى الموسم الأول فقط بالأضافة الى أقل قيمة للشوائب وا لسكر المفقود في المولاس٠
- ان تسميد بنجر السكربمعدل٩٠كجم نيتروجين/ فدان + الرش بالزنك المخلبي بمعدل ١.٥ جم / لتر كان كافيا للحصول على أعلى القيم فى محصول السكر(٤.٢٢ ، ٤.٥٧ طن/فدان) لكن زيادة التسميد النيتروجيني الى ١٢٠ كجم / فدان كان ضروريا للحصول على اعلى محصول عرش(١٠.٠١, ١٠.٧٨ طن/فدان) وجذور(٢٨,٧٧, ٣٢.٦ طن/فدان) فى الموسم الأول والثانى على الترتيب٠

على ذلك يمكن التوصية بتسميد بنجر السكر بمعدل ٩٠ كجم نيتروجين/فدان +الرش بالزنك المخلبي بمعدل ١.٥ جم / لتر للحصول على أعلى محصول من السكر وصفاته التكنولوجية ٠

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