RESULTS AND DISCUSSION

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It is well known that micronutrients play an important role as activators or co-enzymes in many vital processes through different growth stages of sugar beet plants.

The present study was carried out to investigate the performance of sugar beet under different levels of Boron, Zinc, Manganese and their mixture. The three nutrients were applied as soil fertilizers at three application dates.

The obtained results could be presented and discussed under the following topics : growth characters, juice quality as well as chemical constituents at harvest and yield potentialities.

A- Growth Characters

I. Effect of Boron

A_1- Leaf characteristics as affected by Boron :

The effects of Boron on number of leaves, leaf area index (LAI) and top fresh weight of sugar beet during the growth period combined over 1993/ 94 and 1994/ 95 seasons are presented in Table (2).

The statistical analysis of the results revealed no significant differences among the mean values of the three above mentioned characters and among the three application dates as affected by the three B concentrations except for B application date which seemed to

Table (2): Effect of boron fertilizer on number of leaves, leaf area index (LAI) and top fresh weight of sugar beet. (combined over two growing seasons, 1993/94 and 1994/95 .)

Characters	Number of leaves Boron level (kg/fed.)				Leaf area index (LAI) Boron level (kg/fed.)				Top fresh weight (g) Boron level (kg/fed.)			
Application date (D)	0	0.5 kg/fed.	1 kg/fed.	Mean	0	0.5 kg/fed.	1 kg fed.	Mean	0	0.5 kg/fed.	1 kg/fed.	Mean
First sampling date (135 days)												
At Sowing	24.60	27.30	23.60	25.10	6.18	6.15	5.51	5.94	334.60	333.40	312.80	326.90
90 Days	27.40	24.80	28.50	26.90	8.42	7.15	7.45	7.67	437.30	316.10	405.90	386.40
105 Days	25.30	27.70	23.50	25.50	7.25	7.71	8.54	7.83	321.10	359.40	397.00	359.20
Mean	25.80	26.60	25.20	25.80	7.28	7.002	7.17	7.15	364.30	336.30	371.90	357.50
Second sampling date (150 days)												
At Sowing	29.80	27.70	27.60	28.40	6.95	5.23	4.34	5.50	417.10	413.50	411.40	414.03
90 Days	32.20	33.40	27.50	31.03	8.93	4.93	6.43	6.76	438.80	323.05	370.10	377.30
105 Days	27.20	28.20	30.90	28.70	5.03	5.08	5.18	5.09	346.70	364.90	541.30	417.60
Mean	29.70	29.80	28.70	29.40	6.97	5.08	5.31	5.78	400.90	367.20	440.90	402.90
Third sampling date (165 days)												
At Sowing	23.40	22.10	23.70	23.10	5.18	4.33	5.33	4.94	413.20	459.30	463.20	445.20
90 Days	24.90	23.90	23.10	23.90	5.64	4.28	5.30	5.07	460.50	486.90	483.90	477.10
105 Days	26.60	25.70	27.60	26.60	4.90	5.48	5.40	5.26	461.60	510.90	589.90	487.50
Mean	24.90	23.90	24.80	24.50	5.24	4.69	5.34	5.09	445.10	485.70	479.04	469.90
L.S.D at 0.05 level :												
For the first sampling date (135 days)												
Boron	N.S				N.S				N.S			
Application date	N.S				1.49				N.S			
B x D	N.S				N.S				N.S			
For the second sampling date (150 days)												
Boron	N.S				N.S				N.S			
Application date	N.S				N.S				N.S			
B x D	N.S				N.S				128.48			
For the third sampling date (165 days)												
Boron	N.S				N.S				N.S			
Application date	N.S				N.S				N.S			
B x D	N.S				N.S				N.S			

be of significant effect on LAI for the samples taken at 135 days from planting.

1- Number of leaves/ plant :

Concerning the leaves number / plant no any significant effect for B level or date of application was detected throughout the three sampling dates. Application date showed slight differences in number of leaves/ plant at the three sampling dates. Applying B after 90 days from planting showed better effect on this trait at the first as well as the second sampling dates. This treatment produced an increase in leaves number / plant of 7.17 and 9.26 % over the treatment including B application at planting in the samples taken at 135 and 150 days, respectively.

Also, applying B at 90 days induced an increase in number of leaves/ plant by 5.49 and 10.45 % compared with B application after 105 days from planting, respectively in samples taken at 135 and 105 days.

However, all these differences were below the level of significance.

The results revealed also no any apparent effect for B level on leaves number/ plant at all sampling dates. Also, the interaction between B level and application date had no significant effect on number of leaves/ plant.

These results did not agree with those obtained by Morsy and Taha (1986) and Saif (1991) who found that B had pronounced effect on number of leaves/ plant of sugar beet.

2- Leaf area index (LAI) :

Results in Table 2 showed that B level did not significantly affect LAI at all sampling dates. Date of application significantly affected LAI at 135 days (first sampling date). The results showed that applying B after 90 or 105 days significantly increased LAI by 29.12 and 31.82 % compared with applying B at planting, respectively. The significant effect of application date was only detected at the first sampling date, whereas at the second and third sampling dates no any significant effect was observed for B application date on LAI.

The interaction between B levels and application dates did not significantly affect LAI, indicating that each experimental factor acted independently in affecting this character.

It could be concluded that B application had no marked influence on LAI perhaps due to the presence of adequate amount of available B in the soil.

3- Top fresh weight per plant :

Results in Table 2 indicated that B application at 0.5 and 1.0 kg/ fed did not significantly affect top fresh weight/ plant throughout the different growth stages. Also, B application date had no significant effect on this trait.

The only significant effect on top fresh weight/ plant was for the interaction between B level and date of application at 150 days age.

The highest fresh weight at 150 days from planting was 541.3 g which was recorded by applying 1.0 kg B/ fed at 105 days from planting.

The results showed a slight increase in top fresh weight/ plant due to applying 1 kg B/ fed, compared with 0 and 0.5 kg levels. Applying 1 kg B/ fed insignificantly increased top fresh weight by 2.09 and 7.63 % compared with the check treatment at the first and third sampling dates, respectively. These increases were, however, below the level of significance.

It could be concluded that the effect of B was not evident on growth characters of sugar beet under the conditions of the experiment.

These results are not in line with those reported by Morsy and Taha (1986), El-Mashhadi (1988) and Saif (1991), who found that B application significantly and positively affected growth characters of sugar beet.

A_2- Root characteristics ad affected by Boron :

Results for the effect of B on root length, root diameter and root fresh weight of sugar beet combined over 1993/94 and 1994/ 95 seasons are presented in Table (3).

1- Root length :

Results in Table (3) indicated that B application had no significant effect on root length throughout the three growth

Table (3): Effect of boron fertilizer on root length, root diameter and root fresh weight of sugar beet. (combined over two growing seasons, 1993/94 and 1994/95 .)

Characters	Root length (cm) Boron level (kg/fed.)				Root diameter (cm) Boron level (kg/fed.)				Root fresh weight (g) Boron level (kg/fed.)			
Application date (D)	0	0.5 kg/fed	1 kg/fed	Mean	0	0.5 kg/fed	1 kg/fed	Mean	0	0.5 kg/fed	1 kg/fed	Mean
First sampling date (135 days)												
At Sowing	19.70	23.40	21.90	21.70	7.00	7.63	6.55	7.06	387.70	567.80	346.20	433.90
90 Days	21.60	21.60	20.10	21.09	8.25	7.50	7.00	7.58	584.90	423.20	575.90	527.90
105 Days	18.30	20.30	21.10	19.90	6.65	6.78	6.88	6.77	321.60	437.30	546.20	435.03
Mean	19.90	21.70	21.04	20.90	7.30	7.30	6.81	7.14	431.40	476.10	489.40	465.60
Second sampling date (150 days)												
At Sowing	20.90	22.20	23.10	22.10	8.89	8.75	8.28	8.64	582.80	689.30	519.30	597.10
90 Days	23.90	21.50	22.80	22.70	9.25	8.68	9.03	8.98	785.70	700.80	643.20	709.90
105 Days	21.90	21.90	23.30	22.40	8.73	8.45	9.28	8.82	634.10	606.50	771.40	670.70
Mean	22.20	21.90	23.03	22.40	8.96	8.63	8.86	8.81	667.50	665.50	644.60	659.20
Third sampling date (165 days)												
At Sowing	27.20	29.10	27.20	27.80	9.70	10.24	9.90	9.95	759.90	725.90	738.30	741.40
90 Days	28.40	26.60	28.40	27.80	9.90	9.54	9.63	9.69	913.80	740.90	697.40	784.04
105 Days	27.20	25.50	28.20	26.90	9.80	9.55	9.84	9.73	814.00	857.70	808.90	826.90
Mean	27.60	27.10	27.90	27.50	9.80	9.78	9.79	9.79	829.20	774.80	748.20	784.10
L.S.D at 0.05 level :												
For the first sampling date (135 days)												
Boron	N.S				N.S				N.S			
Application date	N.S				0.65				71.70			
B x D	N.S				N.S				N.S			
For the second sampling date (150 days)												
Boron	N.S				N.S				N.S			
Application date	N.S				N.S				75.00			
B x D	N.S				N.S				N.S			
For the third sampling date (165 days)												
Boron	N.S				N.S				N.S			
Application date	N.S				N.S				N,S			
B x D	N.S				N.S				N.S			

periods. Also, date of B application did not significantly influence this trait.

It was observed from the results that 1 kg B/ fed insignificantly increased root length over check treatment by 5.73, 3.78 and 1.09 % at 135, 150 and 165 days from planting, respectively. However, these differences were not great enough to reach the level of significance. The date of B application had no marked effect on root length at the three sampling dates.

The interaction between B application level and date of application had no significant effect on root length at the three sampling dates.

The present results are not in agreement with those obtained by Saif (1991) and Tariq *et al.*, (1993) who found that B application increased root length.

2- Root diameter :

Results indicated that B level had no significant effect on root diameter of sugar beet throughout the three sampling dates. On the other hand, date of B application significantly affected root diameter at the first sampling date (at 135 days). At that period applying B after 90 days from planting produced an increase in root diameter of 11.96 % compared with the later application after 105 days. This increase in root diameter was significant.

B level and application date interaction did not significantly influence root diameter. The present results are not in agreement with those obtained by Saif (1991) and Tariq *et al.*, (1993) who found that B application significantly increased root diameter of sugar beet.

3- Root fresh weight :

Results presented in Table (3) indicated that B levels had no significant effect on root fresh weight throughout the three sampling dates. On the other hand, B application date significantly affected root fresh weight at 135 and 150 sampling dates. At these dates, applying B after 90 days from planting significantly increased root fresh weight by 21.66 and 18.89 % compared with B applied at sowing in the first and second sampling date, respectively. Also, applying B at 90 days from planting significantly increased root fresh weight by 21.35 and 5.84 % compared with later application at 105 days in first and second sampling dates, respectively. At the last sampling date, no significant effect for B application date could be detected.

The effect of the interaction between B levels and date of application did not significantly affect root fresh weight throughout the three sampling dates.

The present results indicated that B is better to be applied at 90 days for a better growth response.

Results obtained by El-Mashhadi (1988) indicated that B application at 1 kg B/ fed produced the highest fresh and dry weight of

tops and roots of sugar beet. Also, Saif (1991) showed that B at 0.5 kg/ fed produced the highest values of number of leaves and fresh and dry weights of tops.

A_3 - Juice quality during the growth period as affected by Boron :

Results for the effect of B fertilizer on TSS %, sucrose % and purity % of sugar beet combined over 1993/ 94 and 1994/ 95 seasons are presented in Table (4).

1- Total soluble solids percentage (TSS %) :

Results in Table (4) indicated no significant effect for B level on TSS % throughout the growing season. The response of this trait to B application was below the significant level and no clear trend could be detected for B level.

The only significant effect was for date of B application at the second sampling date (at 150 days from planting). At this age, the late application of B (after 105 days form planting) was more effective on TSS % compared with application after 90 days.

On the other hand, the three dates of applications were of a similar effect on TSS % at the first as well as the third sampling dates.

The effect of the interaction between B levels and B application dates was not significant throughout the three sampling dates, even in many instances the check treatment showed insignificant increase in TSS %. It could be concluded that under the conditions of the

Table (4): Effect of boron fertilizer on the TSS, sucrose and purity percentages of sugar b et. (combined over two growing seasons, 1993/94 and 1994/95.)

Characters	TSS % Boron level (Kg/fed.)				Sucrose% Boron level (Kg/fed.)				Purity% Boron level (Kg/fed.)			
Application date (D)	0	0.5 kg/fed	1 kg/fed.	Mean	0	0.5 kg/fed	1 kg/fed	Mean	0	0.5 kg/fed	1 kg/fed	Mean
First sampling date (135 days)												
At Sowing	18.50	18.95	18.35	18.60	9.73	9.50	9.25	9.49	52.75	50.25	50.50	51.17
90 Days	19.15	18.15	17.73	18.34	9.65	9.95	9.25	9.62	50.50	55.00	52.00	52.50
105 Days	19.05	18.05	18.65	18.58	9.20	9.80	9.55	9.52	48.28	54.75	51.00	51.34
Mean	18.90	18.38	18.24	18.51	9.53	9.75	9.35	9.54	50.51	53.33	51.17	51.67
Second sampling date (150 days)												
At Sowing	18.40	17.70	18.45	18.18	9.55	10.50	11.60	10.55	52.25	59.25	56.75	56.08
90 Days	18.05	17.80	17.45	17.77	10.50	10.20	10.50	10.40	58.00	57.25	60.25	58.80
105 Days	19.25	18.50	18.05	18.60	10.45	9.05	9.75	9.75	54.75	49.00	54.00	52.58
Mean	18.57	18.00	17.98	18.18	10.17	9.92	10.62	10.23	55.00	55.17	57.00	55.72
Third sampling date (165 days)												
At Sowing	19.00	18.50	18.50	18.67	14.13	13.83	14.10	14.02	74.75	74.75	76.50	75.33
90 Days	19.00	18.88	18.63	18.83	14.66	13.79	13.38	13.94	77.25	73.00	71.25	73.83
105 Days	19.75	18.88	18.50	19.04	14.23	13.93	13.44	13.87	72.50	73.75	73.75	73.33
Mean	19.25	17.75	18.54	18.85	14.34	13.85	13.64	13.94	74.83	73.83	73.83	74.17
L.S.D at 0.05 level: For the first sampling date (135 days)												
Boron	N.S				N.S				N.S			
application date	N.S				N.S				N.S			
B x D	N.S				N.S				N.S			
For the second sampling date (150 days)												
Boron	N.S				N.S				N.S			
application date	0.59				N.S				N.S			
B x D	N.S				N.S				N.S			
For the third sampling date (165 days)												
Boron	N.S				N.S				N.S			
application date	N.S				N.S				N.S			
B x D	N.S				N.S				N.S			

experiments the effect of B level on TSS % during the growth period was not evident. Similar results were also reported by Genaidy (1988) who found that B fertilization at 2 kg B/fed decreased TSS % in juice. On the other hand, Morsy and Taha (1986) as well as Saif (1991) reported that B application increased TSS in roots juice of sugar beet.

2- Sucrose percentage :

Results in Table (4) indicated that B level, application date and their interaction did not significantly influence sucrose % of sugar beet roots throughout the three sampling dates combined over both experimental seasons.

It was observed that sucrose % gradually increased with the advance of growth, being 9.54, 10.23 and 13.94 % as an overall average of all treatments at 135, 150 and 165 days from planting, respectively.

It could be concluded that sucrose % in sugar beet roots at the different growth stages did not respond to B application, probably due to an adequate amount of available B in the soil.

The present results agree with those obtained by Voth *et al.*, (1979), Rustskaya *et al.*, (1981) and Erjala (1986) who found that B application did not significantly affect sugar content in sugar beet.

On the other hand, results reported by Schmidt *et al.*, (1973), Singh and Gangwar (1973), Zolotov and Lavrov (1973), Tadorcic and Faller (1977), Vlasyuk *et al.*, (1977), Kudryashov (1985), Morsy and

Taha (1986), El-Mashhadi (1988), Genaidy (1988) and Saif (1991) showed that B application markedly increased sucrose % in sugar beet.

3- Purity percentage :

Results in Table (4) showed that purity % in sugar beet juice throughout the different growth stages was not significantly affected by B level application date and their interaction.

The data showed no any clear trend for B application on this trait indicating no response of sugar beet during growth stages to B probably due to the presence of this micronutrient in adequate amount in the soil.

The present results are not in agreement with those reported by El- Mashhadi (1988), Genaidy (1988), and Saif (1991) who found that B application to sugar beet markedly improved purity % in root juice.

II- Effect of Zinc :

A_1 - Leaf characteristics as affected by Zinc :

Results for the effects of Zinc application level, date of Zn application and their interaction on number of leaves/ plant, leaf area index (LAI) and top fresh weight/ plant of sugar beet combined over 1993/94 and 1994/95 seasons are presented in Table (5).

1- Number of leaves/ plant :

Results showed that Zn application at 6 kg/ fed significantly reduced leaves number/ plant at the second sampling date compared

Table (5): Effect of zinc fertilizer on number of leaves,leaf area index (LAI) and top fresh weight of sugar beet. (combined over two growing seasons, 1993/94 and 1994/95 .)

Characters	Number of leaves Zn level (kg/fed.)				Leaf area index (LAI) Zn level (kg/fed.)				Top fresh weight (g) Zn level (kg/fed.)			
Application date (D)	0	3 kg/fed	6 kg/fed	Mean	0	3 kg/fed	6 kg/fed	Mean	0	3 kg/fed	6 kg/fed	Mean
First sampling date (135 days)												
At Sowing	25.33	25.03	24.83	25.06	7.90	6.12	7.50	7.17	299.20	429.03	366.35	364.86
90 days	27.83	25.33	24.25	25.80	5.85	7.81	6.73	6.80	399.30	375.38	351.90	375.53
105 Days	26.25	26.48	25.78	26.17	7.90	7.44	7.16	7.50	416.10	362.95	391.00	390.02
Mean	26.47	25.61	24.95	25.68	7.22	7.12	7.13	7.16	371.53	389.12	369.75	376.80
Second sampling date (150 days)												
At Sowing	29.08	26.85	25.93	27.28	5.38	5.10	4.60	5.03	329.05	433.43	406.89	389.79
90 Days	28.15	31.08	22.83	27.35	4.00	5.15	4.18	4.44	338.97	423.30	294.24	352.17
105 Days	30.58	27.50	26.83	28.30	4.75	4.38	5.13	4.75	397.36	422.08	390.53	403.32
Mean	29.27	28.48	25.19	27.64	4.71	4.88	4.63	4.74	355.13	426.27	363.88	381.76
Third sampling date (165 days)												
At Sowing	22.25	24.33	27.15	24.58	4.29	3.68	4.18	4.05	453.31	362.50	485.50	433.77
90 Days	24.93	25.93	25.00	25.28	4.60	4.83	4.58	4.67	499.23	439.10	434.80	457.71
105 Days	25.10	26.85	26.68	26.21	4.15	4.66	5.18	4.66	409.03	453.70	453.38	438.70
Mean	24.09	25.70	26.28	25.36	4.35	4.39	4.64	4.46	453.85	418.43	457.89	443.39
L.S.D at 0.05 level :												
For the first sampling date (135 days)												
Zn	N.S				N.S				N.S			
Application date	N.S				N.S				N.S			
Zn x D	N.S				N.S				N.S			
For the second sampling date (150 days)												
Zn	3.09				N.S				N.S			
Application date	N.S				N.S				N.S			
Zn x D	N.S				N.S				N.S			
For the third sampling date (165 days)												
Zn	N.S				N.S				N.S			
Application date	N.S				0.46				N.S			
Zn x D	N.S				N.S				N.S			

with the check treatment. The reduction in leaves number was 16.02 %, being significant.

This negative effect of Zn application was not observed at the first and third sampling dates. On the other hand, at the third sampling date, the highest Zn level slightly increased number of leaves/ plant by 9.10 % compared with the control treatment. This indicates that sugar beet plants can withstand a higher Zn level and the negative effects are not permanent.

Concerning Zn application date, the results in Table (5) showed no significant response of this trait. However, slight increases were observed as a result of the later application at 105 days age throughout the three growth periods. Applying Zn after 105 days from planting insignificantly increased number of leaves/ plant by 4.43, 3.74 and 6.63%, compared with Zn application at planting, at the first, second and third sampling date, respectively. This result may be due to the greater requirements of sugar beet to Zn at later stages of growth.

The effect of the interaction between Zn levels and application dates did not significantly affect number of leaves/ plant at all sampling dates.

The present results are not in agreement with those obtained by Saif (1991) who found that Zn application produced greater number of leaves per sugar beet plant.

2- Leaf area index (LAI) :

Results in Table (5) indicated no significant effect of Zn application level on LAI throughout the three sampling dates.

Different results were reported by Saif (1991) and Mohamed (1993) who found that Zn application markedly increased growth characters of sugar beet plants.

A_2- Root characteristics as affected by Zinc :

Results for the effects of Zn application on root length, root diameter and root fresh weight of sugar beet combined over 1993/94 and 1994/ 95 seasons are presented in Table (6).

1- Root length :

The results presented in Table (6) indicated no significant effect for Zn level on root length throughout the three sampling dates. Increases in root length were observed in the third sampling date due to Zn application, where Zn applied at 3 and 6 kg/ fed increased root length by 12.47 and 10.18 % compared with the check treatment, respectively. However, these increases were below the level of significance probably due to the great experimental error.

Date of Zn application significantly affected root length at the first sampling date, where the early Zn application at planting significantly surpassed the late application at 105 days from planting by 10.68 %. This effect of application date was not significant at the second and third sampling dates.

The interaction between Zn levels and application dates was only significant at the first sampling date where the greatest response to Zn was associated with earliest application at planting of the middle Zn

Table (6): Effect of zinc fertilizer on root length, root diameter and root fresh weight of sugar beet. (combined over two growing seasons, 1993/94 and 1994/95 .)

Characters / Application date (D)	Root Length (cm) Zn level (kg/fed.)				Root diameter (cm) Zn level (kg/fed.)				Root fresh weight (g) Zn level (kg/fed.)			
	0	3 kg/fed	6 kg/fed	Mean	0	3 kg/fed	6 kg/fed	Mean	0	3 kg/fed	6 kg/fed	Mean
First sampling date (135 days)												
At Sowing	22.33	24.93	21.75	23.00	7.53	8.63	7.40	7.85	550.80	525.80	480.50	522.40
90 days	19.33	21.50	21.08	22.63	7.30	7.15	7.08	7.08	459.30	433.90	370.20	421.10
105 Days	23.28	20.60	20.78	21.55	6.98	7.23	7.25	7.15	441.20	414.60	508.30	454.70
Mean	21.64	22.34	21.20	21.73	7.18	7.67	7.24	7.36	483.70	461.40	453.10	466.10
Second sampling date (150 days)												
At Sowing	22.28	22.00	20.68	21.65	7.88	8.25	8.08	8.07	622.60	574.70	557.10	584.80
90 Days	22.58	21.58	21.73	21.96	8.25	8.23	8.30	8.26	566.90	550.10	500.20	539.10
105 Days	23.58	20.15	21.93	21.88	8.78	7.95	8.73	8.48	568.55	449.90	610.60	543.01
Mean	22.81	21.24	21.44	21.83	8.30	8.14	8.37	8.27	586.04	524.90	555.90	555.60
Third sampling date (165 days)												
At Sowing	26.60	27.93	27.93	27.48	9.75	9.75	9.98	9.83	839.90	962.50	813.10	871.90
90 Days	28.18	27.50	26.00	27.23	9.98	9.68	9.25	9.63	929.70	805.60	1049.30	928.20
105 Days	27.58	27.08	26.90	27.18	9.87	9.60	9.75	9.74	852.90	864.80	845.40	854.40
Mean	24.45	27.50	26.94	27.30	9.86	9.68	9.66	9.73	874.20	877.60	902.60	884.80
L.S.D at 0.05 level :												
For the first sampling date (135 days)												
Zn	N.S				0.37				N.S			
Application date	1.65				N.S				N.S			
Zn x D	2.86				N.S				N.S			
For the second sampling date (150 days)												
Zn	N.S				N.S				N.S			
Application date	N.S				N.S				N.S			
Zn x D	N.S				N.S				N.S			
For the third sampling date (165 days)												
Zn	N.S				N.S				N.S			
Application date	N.S				N.S				N.S			
Zn x D	N.S				N.S				148.22			

level (3 kg. fed). The results showed that this combination produced the maximum root length, being 24.93 cm.

The present results are not in general agreement with those reported by Chernova (1974) and Saif (1991) who found marked increases in growth characters of sugar beet roots due to Zn application

2- Root diameter :

Results in Table (6) indicated that Zn application showed a significant effect on root diameter at the first sampling date. Zn applied at 3 and 6 kg/ fed increased root diameter by 6.82 and 0.84 %, over the check treatment, respectively. The increase due to the middle Zn level (3 kg/ fed) was significant.

The effect of Zn level on root diameter was not clear at the second and third sampling dates where the differences in root diameter were not significant.

Dates of Zn application had no significant effects on root diameter. In general, early Zn application seemed to be more effective on this trait than later application, but without significant differences.

The interaction between Zn levels and application dates had no significant effect on root diameter indicating that both factors independently affected root diameter at the three different sampling dates.

The significant effect of Zn on root growth was also reported by many investigators (Boawn and Viets, 1965; Saif, 1991 and Mohamed, 1993).

3- Root fresh weight :

Results showed that root fresh weight was not significantly affected by Zn level throughout the three sampling dates. However, increases were observed in root fresh weight at the third sampling date where increases of 0.39 and 3.25 % were recorded over the control treatment due to applying Zn at 3 and 6 kg/ fed, respectively. But these increases were, however, too slight to reach the level of significance.

Zn application date had no significant effect on root fresh weight in spite of the increases observed with the early Zn application, particularly at the first sampling date.

The interaction between Zn levels and application dates significantly affected root fresh weight at the third sampling date. At 165 days from planting it was observed that the greatest response to the middle Zn level (3 kg/ fed) was achieved when Zn was applied at planting. On the other hand, the highest response value at the higher Zn level (6 kg/ fed) was recorded when Zn was applied at 90 days age.

The highest root weight was 1049.30 g which was produced by applying Zn at 6 kg/ fed at 90 days from planting.

It could be concluded that the response of root fresh weight to Zn application was not that great as reported in other investigations perhaps due to the high pH value of the experimental soil and to an adequate Zn content.

Results reported by Saif (1991) and Mohamed (1993) indicated a significant response of sugar beet growth characters to Zn application.

A_3- Juice quality during the growth period as affected by Zinc :

Results for the effects of Zn application on total soluble solids (TSS), sucrose percentage and purity percentage of sugar beet during the growth period combined over 1993/ 94 and 1994/ 95 seasons are presented in Table (7).

1- Total soluble solids percentage (TSS %) :

Results in Table (7) indicated a significant effect of Zn application level on TSS % at the third sampling date (165 days from planting). At this sampling date, Zn applied at 6 kg/ fed significantly reduced TSS % compared with the check treatment. The reduction due to the higher Zn level was 0.6 (or 3.23 %) in TSS % reaching the significant level.

A reduction in TSS % was also observed due to applying the higher Zn level at the first and second sampling dates compared with the control treatment, but this reduction was not significant. It was also observed that the lower Zn level (3 kg/ fed) neither increased nor decreased TSS % comparing with the check treatment.

Table (7): Effect of zinc fertilizer on TSS, sucrose and purity percentages of sugar beet (combined over two growing seasons, 1993/94 and 1994/95 .)

Characters	TSS% Zn level (kg/fed.)				Sucrose% Zn level (kg/fed.)				Purity% Zn level (kg/fed.)			
Application date (D)	0	3 kg/fed	6 kg/fed	Mean	0	3 kg/fed	6 kg/fed	Mean	0	3 kg/fed	6 kg/fed	Mean
First sampling date (135 days)												
At Sowing	18.80	17.90	18.30	18.30	10.39	9.40	10.15	9.98	55.80	51.80	55.80	54.40
90 days	18.60	17.90	18.20	18.20	8.70	10.20	10.70	9.87	47.00	57.25	59.00	54.40
105 Days	18.30	17.80	18.20	18.10	8.70	9.50	9.60	9.30	47.80	53.80	52.50	51.30
Mean	18.50	17.90	18.20	18.20	9.30	9.70	10.20	9.70	50.20	54.30	55.80	53.40
Second sampling date (150 days)												
At Sowing	19.00	18.60	17.50	18.30	11.00	10.10	10.50	10.50	58.30	54.50	60.50	57.80
90 Days	18.10	18.30	17.40	17.90	10.90	9.80	9.60	10.10	60.50	53.50	54.80	56.30
105 Days	17.80	18.40	19.10	18.40	10.10	10.80	11.20	10.70	56.50	59.30	58.30	58.00
Mean	18.30	18.40	17.90	18.20	10.70	10.20	10.40	10.40	58.40	55.80	57.80	57.30
Third sampling date (165 days)												
At Sowing	18.50	18.40	18.80	18.60	14.50	13.30	14.50	14.10	78.30	73.00	77.50	76.30
90 Days	19.30	19.40	18.90	19.20	14.50	13.70	14.50	14.20	75.50	71.00	76.80	74.40
105 Days	19.80	19.10	18.30	19.04	14.20	14.60	13.90	14.30	72.00	76.50	76.80	75.10
Mean	19.20	18.90	18.60	18.90	14.40	13.90	14.30	14.20	75.30	73.50	77.00	75.30
L.S.D at 0.05 level :												
For the first sampling date (135 days)												
Zn	N.S				N.S				N.S			
Application date	N.S				N.S				N.S			
Zn x D	N.S				N.S				N.S			
For the second sampling date (150 days)												
Zn	N.S				N.S				N.S			
Application date	N.S				N.S				N.S			
Zn x D	N.S				N.S				N.S			
For the hird sampling date (165 days)												
Zn	0.41				N.S				N.S			
Application date	N.S				N.S				N.S			
Zn x D	0.71				N.S				N.S			

The present results are not in agreement with those obtained by Saif (1991) who reported that Zn applied at 4 kg/ fed recorded the highest value of TSS % in sugar beet.

Concerning the interaction between Zn levels and application dates, results in Table (7) indicated a significant effect on TSS % at the third sampling date. The results revealed that Zn applied to sugar beet plants at 90 dates age was most efficient at 3 kg/ fed, whereas the 6 kg/ fed Zn level was more efficient when applied at sowing date. Zn application at 105 days caused an increase in TSS % compared with the check treatment.

This different response of sugar beet plants to Zn level is an evidence for the interaction effect.

2- Sucrose percentage :

The results in Table (7) indicated that neither Zn levels nor application dates significantly affected sucrose % throughout the three sampling dates. Very slight differences in sucrose %, but without any specific trend, could be observed indicating that this trait was not influenced by Zn application.

Also, the effect of the interaction between Zn levels and application dates was not significant. It was generally observed that the highest sucrose % was 10.70 % at the first sampling date recorded with 6 kg Zn/ fed applied 90 days from planting. At the second sampling date, the highest sucrose % was obtained by combining 6 kg

Zn level with application at 105 days, being 11.20 %. While at the third sampling date the highest sucrose % was 14.60 % recorded with a Zn level of 3 kg/ fed applied at 105 days from planting.

The present results are not in full agreement with those obtained by Monakhova (1976), Kibalenko *et al.*, (1977), Sroller (1978), Vlasyuk *et al.*, (1977), Kalimeri and Pellumbi (1982), Kudryashov (1985), Genaidy (1988) and Saif (1991) who found that Zn application markedly increased sucrose % in sugar beet.

On the other hand, Rutskaya *et al.*, (1981) showed that application of B and Zn to sugar beet caused no changes in sugar contents.

3- Purity percentage :

The results in Table (7) showed that Zn levels, application dates and their interaction had no significant effects on purity % in sugar beet throughout the three sampling dates.

All differences observed in purity % were too slight to reach the level of significance. Moreover, differences were illdefined and showed no specific trend. It could be concluded that under the conditions of the experiments Zn application did not significantly affect purity % in sugar beet during growth period.

The present results are not in agreement with those reported by Kudryashov (1985) and Saif (1991) who found that purity % and quality of sugar beet juice were increased by Zn application.

III- Effect of Manganese

A_1- Leaf characteristics as affected by Manganese :

Results for the effects of Mn application level, Mn application date and their interaction on number of leaves/ plant, leaf area index (LAI) and top fresh weight/ plant of sugar beet combined over 1993/ 94 and 1994/ 95 seasons are presented in Table (8).

1- Number of leaves/ plant :

Results in Table (8) indicated that neither Mn level nor Mn application date significantly affected leaves number/ plant throughout the three sampling dates.

All differences observed in this trait showed no any specific trend indicating no any marked influence for Mn application.

The interaction between Mn levels and application dates on number of leaves/ plant was also not significant. However, the highest value of this trait at the first sampling date was 29.40 which was recorded by Mn at 40 g/ fed applied after 90 days from planting.

At the second sampling date, Mn at 20 g/ fed applied at planting recorded the highest leaves number, being 30.85, whereas at the third sampling date Mn at 40 g/ fed applied after 90 days recorded the maximum number of leaves/ plant averaging 27.15.

The present results may be due to the presence of adequate amounts of available Mn in the experimental soil.

Table (8): Effect of manganese fertilizer on number of leaves,leaf area index (LAI) and top fresh weight of sugar beet. (combined over two growing seasons, 1993/94 and 1994/95 .)

Characters	Number of leaves Mn level (kg/fed.)				Leaf area index (LAI) Mn level (kg/fed.)				Top fresh weight (g) Mn level (kg/fed.)			
Application date (D)	0	20 g/fed	40 g/fed	Mean	0	20 g/fed	40 g/fed	Mean	0	20 g/fed	40 g/fed	Mean
First sampling date (135 days)												
At Sowing	27.00	26.00	25.58	26.19	4.20	6.91	7.06	6.06	355.60	367.40	335.80	352.90
90 days	23.75	26.00	29.40	26.38	6.04	6.77	5.39	6.07	335.80	403.10	417.40	385.40
105 Days	25.50	24.18	24.50	24.73	7.01	6.65	6.08	6.58	382.60	411.50	323.03	372.40
Mean	25.42	25.39	26.49	25.77	5.75	6.78	6.18	6.23	358.01	393.90	358.70	370.20
Second sampling date (150 days)												
At Sowing	29.58	30.85	30.10	30.18	5.03	4.85	5.00	4.96	404.90	403.10	404.80	404.30
90 Days	28.48	25.25	29.60	27.78	5.23	5.58	4.23	5.01	446.20	273.60	355.50	358.40
105 Days	27.75	27.75	28.83	28.11	5.58	4.63	4.80	5.00	444.80	383.80	379.60	402.80
Mean	28.60	27.95	29.51	28.69	5.28	5.11	4.68	4.99	431.90	353.50	379.90	388.50
Third sampling date (165 days)												
At Sowing	26.75	23.58	24.50	24.94	5.73	4.50	4.63	4.95	470.70	376.00	420.60	422.40
90 Days	26.75	23.75	27.15	25.88	5.69	5.18	5.03	5.30	474.20	496.90	497.70	489.60
105 Days	24.40	23.75	25.58	24.58	4.13	4.91	3.43	4.15	401.10	443.10	475.30	439.70
Mean	25.97	23.69	25.74	25.13	5.18	4.86	4.36	4.80	448.70	438.70	464.50	450.60
L.S.D at 0.0.5 level :												
For the first sampling date(135 days)												
Mn	N.S				N.S				N.S			
Application date	N.S				N.S				N.S			
Mn x D	N.S				1.88				N.S			
For the second sampling date (150 days)												
Mn	N.S				N.S				N.S			
Application date	N.S				N.S				N.S			
Mn x D	N.S				N.S				N.S			
For the third sampling date (165 days)												
Mn	N.S				N.S				N.S			
Application date	N.S				N.S				N.S			
Mn x D	N.S				N.S				63.37			

These results are not in agreement with those reported by Morsy and Taha (1986) and Bertic *et al.*, (1987) who found that Mn application increased leaf number and fresh weight of tops of sugar beet.

2- Leaf area index (LAI) :

Results in Table (8) indicated that neither Mn level nor application date significantly influenced LAI throughout the three sampling dates. No any specific trend could be detected from the results for the effect of this element on LAI. The interaction between Mn level and date of application significantly affected LAI at the first sampling date.

The results showed that the highest value of LAI at the first sample was 7.06 which was obtained by Mn applied at sowing at a rate of 40 g/ fed.

The results here did not coincide with those obtained by Chernova (1974), Morsy and Taha (1986) and Mohamed (1993) who found that leaf growth characters of sugar beet were favourably affected by Mn application.

3- Top fresh weight :

Results presented in Table (8) indicated no significant effect for Mn application level on top fresh weight. Also Mn application date had no significant effect on top growth weight.

The only significant effect was the interaction effect between Mn level and application date on top fresh weight at the third sampling date (165 days from planting). At that age, the highest value of top fresh weight was 497.70 g which was recorded by applying Mn after 90 days from planting at 40 g/ fed.

The results here are not coincided with those obtained by Chernova (1974), Morsy and Taha (1986) and Bertic *et al.*, (1974) who found that Mn application increased sugar beet growth.

On the other hand, El-Sayed (1993) noticed that there was a gradual decrease in root fresh weight/ plant due to increasing $MnSo_4$ rate.

A_2- Root characteristics as affected by Manganese :

Results for the effects of Mn level and application date and their interaction on root length, root diameter and root fresh weight of sugar beet throughout the three sampling dates combined over 1993/ 94 and 1994/ 95 seasons are presented in Table (9).

1- Root length :

Results in Table (9) showed that neither Mn level nor Mn application date significantly affected root length of sugar beet throughout the three sampling dates. No any marked differences were observed in this trait due to the experimental factors. Also, the slight differences observed showed no any specific trend for the effect of this trace element on root length.

Table (9): Effect of manganese fertilizer on root length,root diameter and root fresh weight of sugar beet. (combined over two growing seasons,1993/94 and 1994/95 seasons.)

Characters	Root Length (cm) Mn level (kg/fed.)				Root diameter (cm) Mn level (kg/fed.)				Root fresh weight (g) Mn level (kg/fed.)			
Application date (D)	0	20 g/fed	40 g/fed	Mean	0	20 g/fed	40 g/fed	Mean	0	20 g/fed	40 g/fed	Mean
First sampling date (135 days)												
At Sowing	20.83	21.90	20.20	20.98	6.88	7.05	7.50	7.14	394.20	450.03	404.03	416.10
90 days	20.50	19.75	20.90	20.38	6.73	6.63	7.33	6.89	359.40	410.40	412.70	394.20
105 Days	21.33	22.18	20.35	21.28	6.28	6.98	6.40	6.55	361.40	478.90	288.30	376.20
Mean	20.88	21.28	20.48	20.88	6.63	6.88	7.08	6.86	371.70	446.40	368.30	395.50
Second sampling date (150 days)												
At Sowing	21.93	21.0	20.83	21.25	9.08	8.08	9.28	8.81	630.00	615.40	658.70	634.70
90 Days	22.35	23.50	21.93	22.59	8.55	8.65	8.78	8.43	692.40	571.90	563.70	609.30
105 Days	21.10	21.33	21.15	21.19	8.45	8.58	7.75	8.26	706.30	610.30	461.60	592.70
Mean	21.79	21.94	21.30	21.68	8.69	8.44	8.37	8.50	676.20	599.20	560.30	612.30
Third sampling date (165 days)												
At Sowing	26.08	25.68	26.58	26.11	9.84	9.95	9.38	9.72	824.90	778.80	751.70	785.10
90 Days	28.33	26.50	27.75	27.53	9.70	9.70	8.78	9.39	853.70	824.90	782.50	820.40
105 Days	27.68	29.23	27.60	28.17	9.45	10.00	10.62	10.02	806.10	909.10	966.90	894.04
Mean	27.36	27.13	27.31	27.27	9.66	9.88	9.59	9.71	828.20	837.60	833.70	833.20
L.S.D at 0.05 level:												
For the first sampling date (135 days)												
Mn	N.S				N.S				N.S			
Application date	N.S				N.S				N.S			
Mn x D	N.S				N.S				N.S			
For the second sampling date (150 days)												
Mn	N.S				N.S				N.S			
Application date	N.S				N.S				N.S			
Mn x D	N.S				N.S				N.S			
For the third sampling date (165 days)												
Mn	N.S				N.S				N.S			
Application date	N.S				N.S				N.S			
Mn x D	N.S				N.S				N.S			

Similarly, the effect of Mn level x application date on root length through the three sampling dates was no significant.

In general, it was observed that the highest values of root length were 22.18 cm at the first sampling date, 23.50 cm at the second sampling date, and 29.23 cm at the third sampling date, which were recorded by 20 g Mn/ fed applied at 105 , 90 and 105 days from planting, respectively.

It could be concluded that Mn application had no apparent effect on root length probably due to the presence of this microelement in available amounts in the experimental soil.

The present results are not in accordance with those reported by Farley and Draycott (1973), Chernova (1974), and Bertic *et al.*, (1988) who found that Mn application favourably affected root growth of sugar beet.

2- Root diameter :

Results in Table (9) showed that Mn level, Mn application date and their interaction did not significantly affect root diameter throughout the three sampling dates.

It was observed that no any marked differences could be detected in root diameter due to the experimental treatments indicating no apparent role of this microelements on this trait under the conditions of the experiment.

In general, the highest values of root diameter were recorded with Mn at 40 g/ fed applied at planting at the first and second sampling dates, whereas 40 g Mn/ fed applied at 105 days produced the maximum root diameter at the third sampling date. These highest values were 7.50, 9.28 and 10.62 cm, at the first, second, and third sampling date, respectively.

It could be concluded that root growth of sugar beet showed no significant response to Mn application.

The present results did not coincide with those reported by other investigators (Farley and Draycott, 1973; Chernova, 1974; and Bertic *et al.*, 1988) who reported positive effects of Mn on root growth.

3- Root fresh weight :

Data presented in Table (9) indicated no significant effects for Mn level, Mn application date and level x date interaction on root fresh weight throughout the three sampling dates. Root fresh weight followed the same pattern of response to Mn application as that observed with root length and root diameter.

The differences in this trait had no any specific trend either for the effect of Mn level or Mn application date. It seems that the experimental soil contained available amount of Mn that the plants of the check treatment did not suffer from Mn deficiency.

The results are not in agreement with those indicating positive effect of this microelements (Farly and Draycott, 1973; Chernova, 1974

and Bertic *et al.*, 1988) or those showing negative effect of high Mn levels on root weight (El-Sayed, 1993).

A_3- Juice quality during the growth period as affected by Manganese:

Results of the effects of Mn application on total soluble solids (TSS), sucrose and purity percentages of sugar beet during the three sampling dates (135, 150 and 165 days form planting) combined over three sampling dates are presented in Table (10).

1- Total soluble solids percentage (TSS %) :

Results in Table (10) showed that Mn application had a significant effect on TSS % at the first sampling date (135 days from planting).

Results showed that at this growth stage Mn applied at 40 g/ fed increased TSS % by 0.21 and 0.80 compared with zero and 20 g/fed levels, respectively. The difference between the lower and higher Mn levels was significant. This encouraging effect of the higher Mn level on TSS % at the second and third sampling dates was not observed in spite of an apparent increase at the second sampling date.

Date of Mn application had no significant effect on TSS % at all sampling dates and all differences in this trait were far below the level of significance.

Table (10): Effect of manganese fertilizer on TSS, sucrose and purity percentages of sugar beet. (combined over two growing seasons, 1993/94 and 1994/95 seasons.)

Characters	TSS % Mn level (kg/fed.)				Sucrose% Mn level (kg/fed.)				Purity%			
Application date (D)	0	20 g/fed	40 g/fed	Mean	0	20 g/fed	40 g/fed	Mean	0	20 g/fed	40 g/fed	Mean
First sampling date (135 days)												
At Sowing	18.70	17.75	18.55	18.33	8.80	9.10	9.70	9.20	48.50	51.25	52.25	50.67
90 days	18.65	17.45	18.30	18.13	9.50	10.00	9.95	9.82	50.75	55.00	54.50	53.42
105 Days	17.45	17.85	18.60	17.97	8.80	9.00	9.00	8.93	50.50	50.25	48.50	49.75
Mean	18.27	17.68	18.48	18.14	9.03	9.37	9.55	9.32	49.92	52.17	51.75	51.28
Second sampling date (150 days)												
At Sowing	18.05	18.20	18.50	18.25	10.85	10.45	10.10	10.47	60.00	57.25	53.00	56.75
90 Days	17.75	17.70	18.55	18.00	9.48	9.65	10.20	9.78	51.75	54.25	54.75	53.58
105 Days	17.60	17.80	18.05	17.82	11.90	9.25	9.75	10.30	67.50	52.00	53.75	57.75
Mean	17.80	17.90	18.37	18.08	10.74	9.18	10.02	10.18	59.75	54.50	53.83	56.03
Third sampling date (165 days)												
At Sowing	18.50	18.88	18.38	18.58	14.33	14.31	13.64	14.09	77.50	75.75	74.00	75.75
90 Days	18.75	18.50	18.50	18.58	14.43	13.91	14.43	14.25	77.00	75.50	78.00	76.83
105 Days	18.88	18.63	18.75	18.75	14.06	14.00	14.55	14.20	74.75	75.75	80.00	77.00
Mean	18.71	18.67	18.54	18.64	14.27	14.07	14.21	14.18	76.42	75.67	77.50	76.53
L.S.D at 0.05 level:												
For the first sampling date (135 days)												
Mn	0.66				N.S				N.S			
Application date	N.S				0.72				N.S			
Mn x D	N.S				N.S				N.S			
For the second sampling date (150 days)												
Mn	N.S				N.S				N.S			
Application date	N.S				N.S				N.S			
Mn x D	N.S				N.S				N.S			
For the third sampling date (165 days)												
Mn	N.S				N.S				N.S			
Application date	N.S				N.S				N.S			
Mn x D	N.S				0.65				N.S			

Also, the interaction between Mn level and application date had no significant effect on TSS % at all sampling dates, indicating that each experimental factor independently affected this character.

The positive effect of Mn application on TSS % was also reported by Kibalenko *et al.*, (1977), Sroller (1978), Morsy and Taha (1986) as well as El- Sayed (1993).

2- Sucrose percentage :

Results in Table (10) indicated no significant effect of Mn level on sucrose % during the three sampling dates. Some differences were observed in this trait but without any specific trend.

Concerning date of Mn application, results showed a significant effect on sucrose % only at the first sampling date where Mn applied at 90 days significantly surpassed late application after 105 days. At the second and third sampling dates, application date did not significantly influence sucrose %.

The effect of the interaction between Mn level and Mn application date significantly affected sucrose % at the third sampling date. Results showed that the highest sucrose % was 14.55 % which was recorded by applying Mn at 40 g/ fed after 105 days from planting.

The present results are in agreement with those reported by Erjala (1986) who found that sugar content was not affected by Mn application.

On the other hand, many investigators reported significant increase in sucrose % in juice of sugar beet due to Mn application (Tuchashvili and Urtaev, 1971; Zolotov and Larvov, 1973; Sroller, 1978; Kalimeri and Pellumbi, 1982 as well as Morsy and Taha, 1986).

3- Purity percentage :

Results in Table (10) indicated that neither the experimental factors nor their interaction had significant effect on purity % over the three sampling periods. All differences observed in purity % were not of any specific trend to show any apparent response of this trait to Mn level or Mn application date.

It could be concluded that Mn application had no significant effect on purity % of sugar beet juice at all growth periods.

The present results are not in general agreement with those obtained by Morsy and Taha (1986) and El-Sayed (1993) who found that Mn application significantly increased quality characters of sugar beet.

IV- Effect of Boron, Zinc and Manganese mixture :

A_1- Leaf characteristics as affected by B, Zn and Mn mixtures :

Results of the effects of B, Zn and Mn mixture on number of leaves/ plant, leaf area index (LAI) and top fresh weight of sugar beet combined over 1993/ 94 and 1994/ 95 seasons are presented in Table (11).

Table (11): Effect of Mixture fertilizer on number of leaves,leaf area index (LAI) and top fresh weight of sugar beet. (combined over two growing seasons, 1993/94 and 1994/95 s asons.)

Characters	Number of Leaves Mixture level (kg/fed.)				Leaf area index (LAI) Mixture level (kg/fed.)				Top fresh weight (g) Mixture level (kg/fed.)			
Application date (D)	0	0.5+3+ 0.02 kg/fed	1+6+ 0.04 kg/fed	Mean	0	0.5+3+ 0.02 kg/fed	1+6+ 0.04 kg/fed	Mean	0	0.5+3+ 0.02 kg/fed	1+6+ 0.04 kg/fed	Mean
First sampling date (135 days)												
At Sowing	25.00	27.43	24.10	25.51	6.97	7.15	6.77	6.96	433.1	419.8	365.2	409.4
90 days	27.10	24.58	27.43	26.37	6.48	6.24	7.17	6.63	434.3	413.9	382.4	410.2
105 Days	26.60	25.85	25.43	25.96	6.58	5.97	6.48	6.34	334.7	346.7	316.7	332.7
Mean	26.23	25.95	25.65	25.94	6.68	6.45	6.80	6.64	404.3	393.5	354.8	384.1
Second sampling date (150 days)												
At Sowing	28.60	27.85	26.00	27.48	4.48	3.38	5.25	4.37	359.3	320.6	465.9	381.9
90 Days	31.00	30.40	30.00	30.47	5.91	3.55	5.98	5.15	424.6	367.1	451.1	414.3
105 Days	25.75	29.98	28.15	27.96	3.78	5.48	4.33	4.53	440.7	401.4	485.5	442.5
Mean	28.45	29.41	28.05	28.64	4.72	4.13	5.18	4.68	408.2	363.1	467.5	412.9
Third sampling date (165 days)												
At Sowing	21.68	24.25	23.83	23.25	5.13	5.33	3.76	4.74	472.8	472.2	414.9	453.3
90 Days	26.83	24.43	25.83	25.69	5.98	4.71	3.53	4.74	481.5	421.7	442.8	448.7
105 Days	26.93	26.33	26.08	26.44	4.55	4.75	3.90	4.40	420.7	459.8	437.3	439.3
Mean	25.14	25.00	25.24	25.13	5.22	4.93	3.73	4.62	458.3	451.3	431.7	447.1
L.S.D at 0.05 level :												
For the first sampling date (135 days)												
mixtures	N.S				N.S				N.S			
Application date	N.S				N.S				67.05			
mix. x D	N.S				N.S				N.S			
For the second sampling date (150 days)												
mixtures	N.S				N.S				N.S			
Application date	N.S				N.S				N.S			
mix. x D	N.S				N.S				N.S			
For the third sampling date (165 days)												
mixtures	N.S				1.21				N.S			
Application date	2.23				N.S				N.S			
mix. x D	N.S				N.S				N.S			

1- Number of leaves/ plant :

Results showed that the level of microelements mixture did not significantly affect number of leaves throughout the three sampling dates. No any marked differences could be detected due to applying B, Zn, and Mn mixture at both levels used when compared with the check treatment at all sampling dates indicating that this character showed no response to micronutrients application.

Date of applying B, Zn, Mn mixture significantly affected number of leaves only at the third sampling date, where a significant increase in leaves number was recorded due to the later application of the mixture either at 90 or at 105 days from planting compared with application at sowing. Application at 90 and 105 days increased leaves number by 10.49 and 13.72 % compared with application at sowing. This trend was also observed at the first and second sampling dates but the differences were below the level of significance.

The interaction between mixture level and application date was not significant on leaves number at the three sampling dates.

The present results indicate that leaves number per plant is a genetical character which is rarely affected by environmental conditions.

Results reported by Morsy and Taha (1986) (applying B + Mn), Saif (1991) (applying Zn and B) and Mohamed *et al.*, (1993) (applying

B, Zn and Mn) showed that sugar beet growth was favourably affected by microelements application.

2- Leaf area index (LAI) :

The results in Table (11) indicated a significant reduction in LAI due to the application of the three micro elements mixture at the third sampling date. Applying B, Zn, Mn (at 0.5 + 3 + 0.02) and (1 + 6 + 0.04 kg/ fed) reduced LAI by 5.44 and 28.54 % compared with the check treatment.

This negative effect of the higher level of the microelements mixture on LAI was not observed at the first and second sampling dates.

Application date of micro nutrients mixture had no marked effect on LAI at the three sampling dates. Also, the interaction between level and date of application of the mixture did not significantly affect LAI at all sampling dates.

It could be concluded that no clear response of LAI to the micronutrients combination, even a negative effect was observed at later stage of growth.

The present results are not in agreement with these obtained by some investigators who reported favourable effects on growth characters due to single or mixed application of B, Zn and Mn (Morsy and Taha, 1986; Saif, 1991 and Mohamed, 1993).

3- Top fresh weight :

Results in Table (11) showed that applying a mixture of the three micro nutrients (B, Zn and Mn) at two levels did not significantly affect top fresh weight/ plant at the three sampling dates. The differences in this character had no specific trend for a positive response of top fresh weight to the micronutrients mixture, at all growth stages.

Concerning the application date, results showed that at the first sampling date earlier application either at planting or at 90 days from planting was more effective that the later application at 105 days. The results indicated that the latest application date significantly reduced top fresh weight by 16.18 and 18.88 %, compared with application after 90 days and at sowing, respectively.

This positive effect of earlier application of the mixture was not observed at the second and third sampling dates.

The interaction effect between mixture level and application date did not significantly affect top fresh weight of sugar beet at the three sampling dates.

In conclusion, applying B, Zn, Mn mixture did not show clear effect on top fresh weight of sugar beet. The results are not in agreement with those reported by many investigators who found a good response of sugar beet growth to a mixed application of micro elements (Rutskaya *et al.*, 1981; Morsy and Taha, 1986; Saif, 1991 and Mohamed, 1993).

A_2- Root characteristics as affected by B, Zn and Mn mixture :

Results of the effects of the application of B, Zn and Mn mixture on root length, root diameter and root fresh weight of sugar beet combined over 1993/94 and 1994/95 seasons are presented in Table (12).

1- Root length :

The results in Table (12) indicated no significant effect of the micro nutrients mixture on root length. The three levels applied as well as dates of application of the micro nutrients mixture did not induce any apparent effect on root length throughout the three sampling dates.

Also, the interaction between mixture level and application date had no significant effect on root length.

The results showed very slight increases in root length due to applying micro nutrients mixture at the three sampling dates, but the differences were too slight to reach the significant level.

The present results are not in agreement with those reported by Chernova (1974), Rutskaya *et al.*, (1981), Morsy and Taha (1986), Saif (1991), and Mohamed (1993) who found that a mixture of two or three micro nutrients markedly increased root growth of sugar beet.

Table (12): Effect of Mixture fertilizer or root lenght, root diameter,and root fresh weight of sugar beet. (combined over two growing seasons, 1993/94 and 1994/95)

Characters	Root Length (cm) Mixture level (kg/fed.)				Root Diameter (cm) Mixture level (kg/fed.)				Root fresh weight (g) Mixture level (kg/fed.)			
Application date (D)	0	0.5+3+ 0.02 kg/fed	1+6+ 0.04 kg/fed	Mean	0	0.5+3+ 0.02 kg/fed	1+6+ 0.04 kg/fed	Mean	0	0.5+3+ 0.02 kg/fed	1+6+ 0.04 kg/fed	Mean
First sampling date (135 days)												
At Sowing	21.60	23.93	21.68	22.40	6.53	7.28	6.55	6.78	408.0	477.4	347.7	411.0
90 days	21.15	20.93	20.83	20.97	7.70	6.70	7.23	7.21	477.9	389.1	426.5	431.2
105 Days	20.75	20.60	20.50	20.17	6.75	6.85	6.20	6.60	306.7	376.8	289.1	324.2
Mean	21.17	21.82	21.00	21.33	6.99	6.94	6.66	6.86	397.5	414.4	354.4	388.8
Second sampling date (150 days)												
At Sowing	22.58	22.10	21.93	22.20	9.03	8.25	8.38	8.55	639.3	505.3	666.5	603.7
90 Days	22.30	21.58	22.25	22.04	8.88	8.10	8.67	8.55	764.3	463.4	704.5	644.1
105 Days	20.10	22.43	19.10	20.53	8.23	8.67	8.03	8.31	608.9	656.2	627.5	630.8
Mean	21.65	22.03	21.10	21.60	8.71	8.34	8.36	8.47	670.8	541.6	666.2	626.2
Third sampling date (165 days)												
At Sowing	26.68	27.65	28.50	27.60	10.20	9.88	9.18	9.75	793.1	846.7	899.1	846.9
90 Days	26.83	27.26	27.60	27.23	9.58	9.64	9.13	9.45	824.9	776.7	810.4	803.0
105 Days	26.98	27.68	26.98	27.21	10.60	9.85	10.48	10.31	897.7	824.4	885.2	869.1
Mean	26.83	27.53	27.70	27.35	10.13	9.79	9.59	9.84	838.5	815.6	864.9	839.7
L.S.D at 0.05 level :												
For the first sampling date (135 days)												
mixtures	N.S				N.S				N.S			
Application date	N.S				N.S				88.48			
mix. x D	N.S				N.S				N.S			
For the second sampling date (150 days)												
mixtures	N.S				N.S				N.S			
Application date	N.S				N.S				N.S			
mix. x D	N.S				N.S				N.S			
For the third sampling date (165 days)												
mixtures	N.S				N.S				N.S			
Application date	N.S				0.59				N.S			
mix. x D	N.S				N.S				69.09			

2- Root diameter :

The levels of the applied micro nutrients mixture did not significantly influence root diameter of sugar beet at all sampling dates (Table 12).

Concerning application date, the results showed that at the third sampling date, significant differences were observed in root diameter. Applying the micro nutrients mixture at 105 days surpassed the other two earlier dates in their effect on root diameter. The results indicated that applying the mixture at 105 days age increased root diameter in the third sample by 9.10 and 5.74 %, compared with application at 90 days age and at sowing, respectively.

The interaction between level of the mixture and date of application had no significant effect on root diameter at the three sampling dates. It was generally observed that highest values of root diameter were recorded with the check treatment at the three sampling dates being 7.70, 9.03 and 10.60 cm at 135, 150 and 165 days from planting, respectively. Such result indicates clearly that no any response of this character to the applied micro nutrients.

Many investigators reported significant effects of micro elements when applied singly or in combination on root growth of sugar beet (Rosell and Ulrich, 1964; Chernova, 1974; Morsy and Taha, 1986; El-Mashhadi, 1988; Saif, 1991 and Tariq *et al.*, 1993).

3- Root fresh weight :

Results in Table (12) indicated no significant effect of the level of micro nutrients mixture on root fresh weight at the three sampling dates. The differences in this trait were illdefined and showed no any clear trend.

The date of application showed a significant effect on root fresh weight at the first sampling date where application at 90 days significantly surpassed the later application at 105 days by 33.00 % as far as root fresh weight is concerned. Also, application at sowing increased root fresh weight by 26.77 % compared with late application of micro nutrients mixture at 105 days.

This positive effect of an early application of micro elements was not observed at the second and third sampling dates.

Concerning the interaction between level and application date of the mixture, results showed a significant effect on root fresh weight at the third sampling date. The results showed that micro nutrients mixture was more effective when applied early at sowing where the highest level of the mixture significantly increased root fresh weight over the control by 13.37 %. On the other hand, the later application of the higher mixture level showed no significant effect on root fresh weight compared with the check treatment.

In general, the highest value of root fresh weight at the third sampling date was 899.1 g which was produced by applying 1.0 kg B + 6 kg Zn + 40 g Mn/ fed at sowing.

It could be concluded that root fresh weight showed higher response to micro elements when applied early at planting.

The present results are not in general agreement with many investigators who reported marked effects of micro element mixtures on root weight of sugar beet (Morsy and Taha, 1986; Saif, 1991 and Tariq *et al.*, 1993).

A_3- Juice quality during the growth period as affected by B, Zn and Mn mixture.

Results for the effect of applying B, Zn and Mn mixture on total soluble solids (TSS %) sucrose and purity percentages of sugar beet combined over 1993/ 94 and 1994/ 95 seasons are presented in Table (13).

1- Total soluble solids percentage (TSS %) :

Results in Table (13) showed that neither levels of micro nutrients mixture nor application dates had significant effect on TSS % at the three sampling dates. Also, no significant effect was detected for the interaction between levels and dates of micro nutrients mixture application on TSS %. All differences in this trait were very slight and far below the level of significance.

Table (13): Effect of Mixture fertilizer on the TSS , Sucrose and purity percentages of sugar beet. (combined over two growing Seasons, 1993/94 an ' 1994/95)

Characters	TSS % Mixture level (Kg/fed.)				Sucrose % Mixture level (Kg/fed.)				Purity% Mixture level (kg/fed.)			
Application date (D)	0	0.5+3+ 0.02 kg/fed	1+6+ 0.04 kg/fed	Mean	0	0.5+3+ 0.02 kg/fed	1+6+ 0.04 kg/fed	Mean	0	0.5+3+ 0.02 kg/fed	1+6+ 0.04 kg/fed	Mean
First sampling date (135 days)												
At Sowing	18.35	18.55	17.95	18.28	8.35	8.60	9.20	8.72	45.80	46.50	51.50	47.90
90 days	18.25	18.50	17.75	18.17	9.20	9.75	9.35	9.43	50.50	53.00	52.80	52.10
105 Days	17.75	18.90	18.25	18.30	8.50	10.85	9.10	9.48	48.00	57.30	52.80	52.70
Mean	18.12	18.65	17.98	18.25	8.68	9.73	9.22	9.21	48.10	58.30	52.30	50.90
Second sampling date (150 days)												
At Sowing	17.75	18.60	18.60	18.65	11.65	11.00	11.60	11.42	62.30	59.30	62.80	61.40
90 Days	18.60	18.30	17.85	18.25	10.40	10.06	10.35	10.27	56.00	55.00	58.50	56.50
105 Days	17.80	17.50	17.80	17.70	9.25	10.65	8.95	9.62	52.00	60.80	50.30	54.30
Mean	18.38	18.13	18.08	18.20	10.43	10.57	10.30	10.43	56.80	58.30	57.20	57.40
Third sampling date (165 days)												
At Sowing	18.50	19.00	18.88	18.79	13.89	14.09	13.78	13.92	75.30	74.30	73.80	74.40
90 Days	19.25	19.75	19.13	19.38	14.90	13.80	13.84	13.88	73.000	69.30	74.00	72.10
105 Days	18.50	19.00	18.25	18.58	14.20	14.10	14.04	14.13	76.807	74.80	77.00	76.20
Mean	18.75	19.25	18.75	18.92	14.03	14.02	13.88	13.98	75.00	72.80	74.90	74.20
L.S.D at 0.05 level :												
For the first sampling date (135 days)												
mixtures	N.S				N.S				N.S			
D	N.S				N.S				N.S			
mix. x D	N.S				N.S				N.S			
For the second sampling date (150 days)												
mixtures	N.S				N.S				N.S			
D	N.S				N.S				N.S			
mix. x D	N.S				N.S				N.S			
For the third sampling date (165 days)												
mixtures	N.S				N.S				N.S			
D	N.S				N.S				N.S			
mix. x D	N.S				N.S				N.S			

It could be concluded that under the conditions of the experiments TSS % of sugar beet juice at the three growth stages (135, 150 and 165 days form planting) showed no any response to the combined application of B, Zn and Mn mixture.

The present results are not in agreement with those obtained by Genaidy (1988) who found that B application decreased TSS % in juice. On the other hand, Saif (1991) reported that B and Zn application produced the highest values of TSS %.

2- Sucrose percentage :

The results in Table (13) showed that levels as well as dates of the application of micro nutrients did not significantly affect sucrose % at the three sampling dates. Also, level x date of micro nutrients application showed no significant effect on this trait throughout the three sampling dates.

The slight differences observed in this character were illdefined and far below the level of significance.

The results are not in agreement with those reported by Voinava (1965), El- Hady (1969), Omelchenko (1970), Radchenko (1970), El-Kobbia *et al.*, (1971), Schmidt *et al.*, (1973), Singh and Gangwar (1974), Saif (1991), El- Sayed (1993) and Tariq *et al.*, (1993) who found that the micro nutrients in single or combined application increased sucrose % of sugar beet juice.

On the other hand, Voth *et al.*, (1979) reported the B application did not significantly affect sugar content.

3- Purity percentage :

Neither levels nor dates of applying micro nutrients mixture had significant effect on purity % at the three sampling dates.

The differences observed in purity % of sugar beet juice had no any specific trend indicating that purity % showed no response to the studied treatments.

The results here are not coincided with those obtained by El-Mashhadi (1988), Fuhering and Finker (1973), Saif (1991), and Tariq *et al.*, (1993) who found that application of micro nutrients raised purity % of sugar beet juice.

This result is expected since miceonutrients mixture did not affect TSS % as well as sucrose % as indicated in Table (13).

B- Juice Quality at Harvest

Juice Quality at Harvest as affected by B, Zn and Mn as single and combined application :

Results for the effects of B, Zn and Mn either alone or mixed at two levels and at different dates on juice quality at harvest combined over 1993/ 94 and 1994/ 95 seasons are presented in Table (14).

B_1- Total soluble solids percentage (TSS %) :

Results in Table (14) showed that B single application at the higher level, i.e. 1 kg/ fed significantly increased TSS % at harvest

Table (14): Effect of Boron, Zinc, Manganese and their Mixture on TSS, sucrose and purity percentages of sugar beet at harvest. (combined over two growing seasons, 1993/94 and 1994/95 .)

Characters	TSS % Application date (D)				Sucrose % Application date (D)				Purity % Application date (D)			
B, Zn, Mn and Miture level.	At Sowing	90 Days	105 days	Mean	At Sowing	90 Days	105 days	Mean	At Sowing	90 Days	105 days	Mean
0	24.00	24.00	24.00	24.00	14.90	15.50	16.30	15.60	61.90	64.70	68.30	64.90
B 0.5 kg/fed	23.75	23.50	23.30	23.50	15.90	16.30	16.40	16.20	67.30	69.50	70.50	69.10
1 kg/fed.	24.25	24.50	24.00	24.30	16.80	17.20	17.70	17.20	69.40	70.10	73.60	71.02
Mean	24.00	24.00	23.80	23.90	15.90	16.30	16.80	16.30	66.20	68.10	70.80	68.40
0	23.50	23.50	23.80	23.60	15.00	15.00	16.00	15.30	63.80	63.70	67.50	64.90
Zn 3 kg/fed	24.00	24.25	24.30	24.20	15.40	16.00	15.90	15.80	64.30	66.00	65.80	65.40
6 kg/fed.	23.75	23.50	24.30	23.80	16.10	16.90	17.30	16.80	67.90	71.80	71.40	70.30
Mean	23.75	23.80	24.10	23.90	15.50	15.90	16.40	15.90	65.30	67.20	68.20	66.90
0	24.25	24.30	23.30	23.90	14.90	15.10	15.90	15.30	61.50	59.80	68.70	63.30
Mn 20 g/fed	24.00	24.30	23.50	23.90	14.70	15.20	16.20	15.40	61.30	62.90	69.30	64.50
40 g/fed.	23.75	24.00	23.80	23.80	15.90	16.70	17.20	16.60	67.20	69.50	72.70	69.80
Mean	24.00	24.20	23.50	23.90	15.20	15.70	16.50	15.80	63.30	64.10	70.20	65.90
B + Zn + Mn												
0	23.50	24.00	24.00	23.80	15.30	15.10	15.90	15.40	65.04	62.20	66.40	64.50
0.5+3+0.02kg/fed.	23.75	23.50	24.00	23.80	15.70	16.30	16.80	16.30	66.30	69.30	69.90	68.50
1+6+0.04 kg/fed.	23.75	23.50	23.80	23.70	17.08	17.10	18.10	17.40	71.20	72.90	76.30	73.50
Mean	23.67	23.67	23.90	23.80	16.02	16.10	16.90	16.40	67.50	68.10	80.90	68.80
L.S.D at 0.05 level :												
B	0.61				N.S				N.S			
Application date	N.S				N.S				N.S			
B X D	N.S				N.S				N.S			
Zn	N.S				N.S				N.S			
Application date	N.S				N.S				N.S			
Zn X D	N.S				N.S				N.S			
Mn	N.S				N.S				N.S			
Application date	N.S				N.S				4.46			
Mn X D	N.S				N.S				N.S			
Mixtures	N.S				N.S				N.S			
Application date	N.S				N.S				2.46			
mix. X D	N.S				N.S				N.S			

compared with the lower level (0.5 kg/ fed). The results in Table (14) showed that B applied at 1 kg/ fed increased TSS % by 0.3 and 0.8 % compared with zero, and 0.5 kg/ fed level, respectively.

All other elements either applied alone or in combination did not significantly affect TSS %.

Date of application of all micro nutrients had no any marked effects on TSS % of sugar beet juice at harvest. Also, the effect of the interaction between nutrients level and application date showed no significant effects on TSS %.

It could be concluded that B application at 1.0 kg/ fed showed positive effect on TSS % in juice at harvest. Similar results for the positive effect of B on TSS % were also reported by Sroller (1978) and Saif (1991).

On the other hand, Genaidy (1988) found that B application at 2 kg/ fed decreased TSS % in juice of sugar beet.

B_2- Sucrose percentage :

Results in Table (14) showed that all micro nutrients at all levels applied and at the three application dates had no significant effect on sucrose % in sugar beet juice at harvest. The results showed that applying B, Zn, Mn and B + Zn + Mn at the lower level insignificantly increased sucrose % by 0.5, 0.5, 0.1 and 0.9 % respectively, compared with the check treatment.

Also, B, Zn, Mn and their mixture at the highest level insignificantly increased sucrose % at harvest by 1.60, 1.50, 1.30 and 2.00 % compared with the check treatment, respectively. These increases in sucrose % in juice were, however, below the level of significance probably due to the small number of replications available for the juice quality measurements.

The interaction between microelement levels and application dates had no significant effects on sucrose % in juice at harvest, for all micronutrients as well as for their mixture.

However, a clear trend was observed where the highest values of sucrose % were recorded with all micronutrients when applied at the higher level, namely 1 kg B, 6 kg Zn, 40 g Mn and 1 kg B + 6 kg Zn + 40 g Mn/ fed, when these levels were applied 105 days from planting. The highest sucrose percentages were 17.7, 17.3, 17.2 and 18.1 %, recorded with the highest B, Zn, Mn and B + Zn + Mn, respectively when applied at 105 days from planting.

The general trend of the results indicates that the higher micro nutrients level combined with the late application at 105 days had a positive effect, particularly when applied as a mixture for the three elements on sucrose % of sugar beet juice at harvest.

The positive effects of the three micro nutrients on sucrose % in sugar beet juice at harvest were reported by Voinova (1965), Bamberg (1966), Omelchenko (1970), Radchenko (1970), Yaremenko (1970), El-Kobbia (1971), Dolya and Ostrovskii (1971), Schmidt *et al.*, (1973),

Zolotov and Lavrov (1973), Singh and Gangwar (1974), Sviridov (1975), Todorcic and Faller (1977), Emelyanova (1978), Sapatyi (1978), Morsy and Taha (1986), El- Mashhadi (1988) and Saif (1991) with B application.

The positive effect of Zn on sucrose % was also reported by Omelchenko and Shadrina (1974), Monakhova (1976), Zavrel (1978) Shalavitskaya (1979), Fuhering and Finker (1973) as well as Saif (1991).

Concerning Mn effect on sucrose %, Zolotov and Lavrov (1973), as well as Morsy and Taha (1986) found that sucrose % in sugar beet juice significantly increased due to the application of Mn.

Also, the positive effect of two or more of these micro nutrients on sucrose % was also reported by many investigators (Omelchenko, 1970; Kibalenko *et al.*, 1977; Vlasyuk *et al.*, 1977; Kalimeri and Pellumbi, 1982; Morsy and Taha, 1988; as well as Saif, 1991).

B_3- Purity percentage :

Results in Table (14) indicated that micro nutrients increased purity % of sugar beet juice at harvest. The increase in purity % due to micro nutrients application reached the significant level with Mn where the highest Mn level significantly increased purity % compared with the check treatment and the lower level as well.

The results showed that applying B, Zn, Mn and B + Zn + Mn at the lower levels (0.5 kg B, 3 kg Zn, 20 g Mn, 0.5 kg B + 3 kg Zn + 20 g

Mn/ fed, respectively) increased purity % by 4.2, 0.5, 1.2 and 4.0 %, respectively.

Moreover, the higher level of micro nutrients (1 kg B, 6 kg Zn, 40 g Mn and 1 kg B + 6 kg Zn + 40 g Mn/ fed) increased purity % compared with the check treatment by 6.12, 5.40, 6.50 and 9.0 %, respectively. These considerable increases were only significant with Mn application.

It could be concluded that the application of B, Zn and Mn and their mixture favourably affected purity % particularly when these elements were applied at the higher level. The greatest increases were recorded with mixture application.

The effect of application date of the mixed nutrients showed significant effect on purity %. The later application at 105 days significantly surpassed the earlier application at planting in effecting purity %.

Purity percentages were 67.50, 68.10 and 80. 90 %, when the micro nutrients mixture was applied at sowing, 90 and 105 days, respectively.

It is worth mentioning that with all single micro elements, the later application increased purity % compared with earlier application, but the considerable differences in purity % were not significant.

C- Chemical constituents at harvest

C_1- N and K % in Sugar Beet Leaves and Roots as affected by Single and Combined Application of B, Zn and Mn:

The results presented in Table (15) show the effects of the single and combined application of B, Zn and Mn at two levels and at three dates on N, and K contents in leaves and roots of sugar beet at harvest combined over 1993/94 and 1994/ 95 season.

1- Nitrogen content in leaves :

The results in Table (15) showed that N % in leaves was significantly affected by applying a mixture of the three micro nutrients. The results indicated a significant increase in N % in leaves due to application of a mixture containing 0.5 kg B + 3 kg Zn + 20 g Mn/ fed compared with the check treatment and the highest level as well.

All other micro nutrients applied alone showed no significant effect on N% in leaves when applied at two levels. Some slight differences were observed in N % due to applying micro nutrients, but without any specific trend, and the differences were below the significant level.

Date of application of all nutrients did not significantly affect N % in leaves . Also, no significant interaction between levels and dates of micro nutrients application on N % in leaves.

It could be concluded that a mixture of the three micro elements at the lower level induced an increase in N % in leaves.

Table (15): Effect of level and application date of boron, zinc, manganese and their mixtures on N and K (%) percentages of sugar beet leaves and roots at harvest. (combined over two growing seasons, 1993/94 and 1994/95 .)

Characters	Leaves (N. %) Application date (D)				Roots (N. %) Application date (D)				Leaves (K. %) Application date (D)				Roots (K. %) Application date (D)			
B, Zn, Mn and Mixture levels	at sowing	90 days	105 days	Mean	at sowing	90 days	105 days	Mean	at sowing	90 days	105 days	Mean	at sowing	90 days	105 days	Mean
Boron experiment																
0	3.30	3.10	2.90	3.10	1.70	1.60	1.60	1.60	4.00	3.80	4.00	3.90	1.80	1.60	1.90	1.80
0.5 kg /fed.	3.20	3.10	2.30	2.90	1.00	1.20	1.30	1.10	3.60	3.90	3.80	3.80	1.80	1.70	2.00	1.80
1 kg /fed.	3.90	3.40	4.00	3.80	0.90	1.10	1.00	1.00	3.90	3.90	4.40	4.10	2.20	2.00	2.10	2.10
Mean	3.40	3.20	3.10	3.20	1.20	1.30	1.50	1.30	3.80	3.90	4.10	3.90	1.90	1.80	2.00	1.90
Zinc experiment																
0	2.90	3.20	3.50	3.20	1.90	1.30	1.20	1.40	3.90	3.70	3.70	3.70	1.80	1.80	1.80	1.80
3 kg /fed.	3.40	3.80	3.50	3.60	1.30	1.30	1.00	1.20	3.50	3.50	3.70	3.50	1.70	1.90	1.90	1.90
6 kg /fed.	3.00	3.40	3.50	3.30	1.20	1.20	1.30	1.20	3.90	3.90	4.20	3.90	2.30	2.10	2.40	2.30
Mean	3.10	3.50	3.50	3.40	1.50	1.30	1.20	1.30	3.80	3.70	3.80	3.70	1.90	1.90	2.03	2.00
Manganese experiment																
0	3.30	3.60	3.20	3.30	1.50	1.30	1.10	1.30	3.80	3.70	4.10	3.80	1.90	1.60	1.80	1.80
20 g /fed.	4.50	4.30	3.90	4.20	1.30	1.30	2.10	1.20	3.60	3.90	3.80	3.80	1.80	1.90	1.90	1.90
40 g /fed.	3.00	3.10	3.20	3.10	1.20	1.60	1.10	1.30	4.00	4.00	3.90	3.90	2.10	2.20	2.20	2.20
Mean	3.60	3.70	3.40	3.60	1.30	1.40	1.10	1.30	3.80	3.90	3.90	3.90	1.90	1.90	1.90	1.90
Mixture experiment																
0	3.40	3.40	3.30	3.30	1.40	1.30	1.40	1.30	3.60	3.70	3.80	3.70	1.80	2.00	1.60	1.80
0.5+3+0.02 kg/f.	3.30	3.30	3.70	3.50	1.30	1.20	1.30	1.20	3.60	3.70	3.80	3.70	1.70	2.00	1.60	1.80
1+6+0.04 kg/f	3.20	3.30	3.10	3.20	0.90	1.40	1.30	1.20	3.90	4.20	4.40	4.20	2.10	2.00	2.40	2.10
Mean	3.30	3.30	3.30	3.30	1.20	1.30	1.30	1.30	3.70	3.90	4.00	3.90	1.86	2.00	1.90	1.90

L.S.D. at 0.05 level :				
B	N.S	N.S	N.S	N.S
Application date	N.S	N.S	N.S	N.S
B x D	N.S	N.S	N.S	N.S
Zn	N.S	N.S	0.29	0.4
Application date	N.S	N.S	N.S	N.S
Zn x D	N.S	N.S	N.S	N.S
Mn	N.S	N.S	N.S	N.S
Application date	N.S	0.2	N.S	N.S
Mn x D	N.S	N.S	N.S	N.S
mixtures	0.21	N.S	N.S	N.S
Application date	N.S	N.S	N.S	N.S
mix x D	N.S	N.S	N.S	N.S

Results reported by Rosell and Ulrich (1964) (applying Zn), Voinova (1965) (applying B), Aizupiete (1986) (applying B), Radchenko (1970) (applying B), Byasov (1972) (applying B), Chernova (1974) (applying Mn), Mazurenko *et al.*, (1988) (applying B and Zn), as well as Morsy and Taha (1986) (applying B and Mn) showed that N % in leaves increased due to application of micro nutrients.

On the other hand, negative effects on N % in leaves due to micro nutrients application were reported by Tadorcic and Faller (1977) (applying B) and Anikeev *et al.*, (1978) (applying B).

2- Nitrogen content in roots :

Results in Table (15) showed that all micro nutrients applied singly or combined at both levels had no significant effect on N % in sugar beet roots at harvest. It is observed that no any increase in root N content supplied with B, Zn, Mn or their mixture.

The only significant effect was for application date for Mn, where application at 90 days from planting or at sowing significantly surpassed the later application at 105 days age in affecting N % in roots. The effect of the interaction between levels and dates of application did not significantly influence N % in leaves.

It could be concluded that N % in roots showed no significant response to micro nutrients . Results reported by Voinova (1965) (applying B), Radchenko (1970) (applying B), Byasov (1972), (applying B), Dolya and Ostrovskii (1971) (applying B), Stoyanov

(1971) (applying B) as well as Morsy and Taha (1986) (applying B + Mn) indicated a significant increase in root N % due to applying micro elements.

On the other hand, Tadorcic and Faller (1977), Anikeev et al (1978) and Nelyubova and Starovoitova (1980) showed opposite results where they found that B application decreased the N content in sugar beet roots.

3- Potassium content in leaves :

Results in Table (15) showed that K % in leaves increased significantly due to the application of the highest Zn level compared with the lower level.

It was generally observed that with all micro nutrients as well as their mixture a considerable increase in K % in leaves of sugar beet at harvest was observed when these nutrients were applied at the higher level. The increases were not significant probably due to the small number of replications and to a high experimental error.

Date of application had no significant effect. However, slight increase was observed in K % in leaves due to the later application of the micro nutrients at 105 days age.

Level x date of micro nutrients application did not significantly affect K % in leaves at harvest. In general, the highest K % was recorded with applying the highest micro nutrients level at the latest

application date. That was clear with B, Zn and B + Zn + Mn application, where K % was 4.40, 4.42 and 4.40 %, respectively.

It could be concluded that micro nutrients favourably affected K % in leaves. Results reported by Aizupiete (1968), El- Hady (1969), Sroller (1978), Bonilla *et al.*, (1980), Mazurenko *et al.*, (1980) as well as Morsy and Taha (1986) showed that micro nutrients such as B, Zn and Mn increased K % in sugar beet leaves.

On the other hand El- Mashhadi (1988) reported that B application did not significantly increase the total uptake of B and K in sugar beet plant.

4- Potassium content in roots :

Results in Table (15) showed that micro nutrients application induced some increases in K % in sugar beet roots at harvest. In general, most increases in K % were clear but, mostly below the level of significance.

The only significant effect was for Zn when it was applied at the higher level. This effect was also recorded in K % in sugar beet leaves.

The general trend of the results indicated also that the application date did not significantly affect K % in roots.

The level x application date interaction had no significant effect on K % in roots. However, the highest K % values were almost

recorded with the highest level combined with the latest date. K % was 2.10, 2.40, 2.20 and 2.40 % for the highest levels of B, Zn, Mn and their mixture, respectively when applied at 105 days age.

It could be concluded that a favourable effect was observed for micro nutrients application on K % in sugar beet roots. The positive effect of micro elements on K uptake by sugar beet plants was also reported by several investigators (Bonilla et al, 1980; as well as Morsy and Taha, 1986).

C_2- B, Zn and Mn % in Sugar Beet Leaves and Roots as affected by Single and Combined Application of B, Zn and Mn :

The results for the effects of the application of B, Zn, Mn and their mixture at two levels and three application dates on B, Zn and Mn contents in sugar beet leaves and roots at harvest are presented in Table (16).

1- B content in leaves :

The results in Table (16) showed that neither levels nor dates of application of the three micro nutrients and their mixture significantly affected B concentration in sugar beet leaves.

It can be observed that very slight increases in B content in leaves are found particularly when B or B + Zn + Mn were applied. All differences in B content were very slight to reach the significant

Table (16):Effect of levels and application date of Boron, Zinc, Manganese and theirMixture on B,Zn,Mn concentration (ppm) of Sugar beet leaves and roots at harvest. (combined over two growing seasons, 1993/94 and 1994/95 seasons.)

Characters	Leaves (B. ppm) Application date (D)				Roots (B. ppm) Application date (D)				Leaves (Zn. ppm) Application date (D)				Roots (Zn.. ppm) Application date (D)				Leaves (Mn. ppm) Application date				Roots (Mn. ppm) Application date			
B, Zn, Mn and Mixture level	at sowing	90 days	105 days	Mean	at sowing	90 days	105 days	Mean	at sowing	90 days	105 days	Mean	at sowing	90 days	105 days	Mean	at sowing	90 days	105 days	Mean	at sowing	90 days	105 days	Mean
Boron Experiment																								
0	30.80	31.80	32.50	31.70	8.50	9.50	10.50	9.50	12.50	12.50	14.30	13.10	9.80	10.80	11.80	10.80	21.50	24.00	25.0	23.50	15.00	16.30	16.80	16.00
0.5 kg /fed.	32.80	34.30	34.80	33.90	11.50	11.50	12.00	11.70	13.50	15.00	17.00	15.20	11.80	12.00	13.50	12.40	24.50	26.00	28.0	26.20	15.50	15.80	16.50	15.90
1 kg /fed.	34.00	34.30	35.00	34.40	13.50	14.50	14.30	14.10	15.80	16.00	17.50	16.40	13.50	13.50	14.00	13.70	26.00	27.00	28.0	27.00	17.50	18.80	21.50	19.30
Mean	32.50	33.40	34.10	33.30	11.20	11.80	12.30	11.80	13.90	14.50	16.30	14.90	11.70	12.10	13.10	12.30	24.00	25.70	27.0	25.60	16.00	16.90	18.30	17.10
Zinc Experiment																								
0	28.50	29.50	30.00	29.30	9.80	9.00	9.00	9.30	15.00	15.30	16.00	15.40	8.00	11.00	12.00	11.00	21.50	24.50	26.00	24.00	14.50	15.80	17.00	15.80
3 kg /fed.	30.80	31.00	30.50	30.80	10.50	10.30	11.50	10.80	23.00	23.00	23.50	23.20	13.50	17.00	15.50	15.30	24.80	24.30	26.80	25.30	15.80	16.00	17.30	16.30
6 kg /fed.	30.80	31.00	32.30	31.30	11.30	12.00	13.30	12.20	28.00	31.80	33.50	31.10	16.30	18.80	18.80	17.90	29.30	30.80	31.80	30.60	17.30	17.50	20.30	18.30
Mean	30.00	30.50	30.90	30.50	10.50	10.40	11.30	10.70	22.00	23.30	24.30	23.20	13.30	15.60	15.40	14.80	25.20	26.50	28.20	26.60	15.80	16.40	18.20	16.80
Manganese Experiment																								
0	29.00	29.00	30.00	29.30	9.50	9.00	8.80	9.10	12.50	12.80	14.00	13.10	9.80	10.80	11.80	10.80	21.50	23.50	25.50	23.50	22.00	22.50	22.50	22.30
20 g /fed.	29.50	30.00	30.50	30.00	10.50	10.50	10.30	10.40	18.50	18.00	16.80	17.80	12.50	13.80	12.50	12.90	29.50	32.30	34.00	31.90	22.00	23.00	25.00	23.30
40 g /fed.	31.80	31.00	31.50	31.40	11.00	10.80	12.00	11.30	19.80	16.50	20.00	18.80	13.50	15.30	15.30	14.70	33.00	34.80	35.50	34.40	22.50	23.50	25.00	23.70
Mean	30.10	30.00	30.70	30.30	10.30	10.10	10.30	10.30	16.80	15.80	16.90	16.50	11.90	13.30	13.20	12.80	28.00	30.20	31.70	29.90	22.20	23.00	24.20	23.10
Mixture Experiment																								
0	30.80	32.50	32.30	31.80	9.80	9.80	9.80	9.80	14.00	16.50	16.30	15.60	9.50	11.50	13.30	11.40	21.50	23.30	24.80	23.20	22.00	22.80	24.00	22.90
0.5+3+0.02 kg/fed	34.50	36.00	34.50	35.00	12.80	13.00	13.30	13.00	20.50	23.50	22.50	22.20	12.80	15.50	17.30	15.20	27.00	29.00	30.30	28.80	21.30	22.30	23.80	22.40
1+6+0.04 kg/fed	34.30	35.00	34.80	34.70	14.30	13.30	14.50	14.00	27.50	28.50	33.30	29.80	17.50	19.30	19.50	18.80	32.80	34.30	35.30	34.10	22.80	23.30	24.80	23.60
Mean	33.20	34.50	33.80	33.80	12.30	12.00	12.50	12.30	20.70	22.80	24.00	22.50	13.30	15.40	16.70	15.10	27.10	28.80	30.10	28.70	22.00	22.80	24.20	22.90
L.S.D at 0.05 level of significant																								
B	N.S				N.S				N.S				N.S				N.S				N.S			
D	N.S				N.S				N.S				N.S				N.S				N.S			
B x D	N.S				N.S				N.S				N.S				N.S				N.S			
Zn	N.S				N.S				N.S				N.S				N.S				N.S			
D	N.S				N.S				N.S				1.19				N.S				N.S			
Zn x D	N.S				N.S				N.S				N.S				N.S				N.S			
Mn	N.S				N.S				N.S				N.S				N.S				N.S			
D	N.S				N.S				N.S				1.17				N.S				N.S			
Mn x D	N.S				N.S				N.S				N.S				N.S				N.S			
mixtures	N.S				N.S				N.S				N.S				N.S				N.S			
D	N.S				N.S				N.S				N.S				N.S				N.S			
mix. x D	N.S				N.S				2.43				N.S				N.S				N.S			

level. The effect of application date on B content in leaves had no specific trend and all differences due to application date are negligible .

Similarly, the levels x application date effect on B concentration in leaves was not significant. From the present results it could be concluded that B application showed no marked effect on B concentration in leaves. It is clear from Table (16) that the check plants contained from 30.00 to 32.50 ppm B and the plants treated with B contained from 33.40 to 34.50 ppm.

It was reported that the B concentration in sugar beet tops at harvest was 40 ppm and the symptoms of B deficiency did not appear when B concentration in the leaf was greater than 30 ppm, but symptoms were found when the concentration fell below 20 ppm (Draycott and Holliday, 1970).

Consequently, the experimental soil was fit to supply sugar beet plants with their B requirements.

Results reported by El-Hady (1969), Voth (1978), Morsy and Taha (1986) as well as Tariq *et al.*, (1993) indicated that B application to sugar beet markedly increased B content in leaves.

On the other hand, Krauze *et al.*, (1986) and El-Mashhadi (1988) showed that B application did not ensure an increase in B levels in sugar beet plants.

2- B content in roots :

Results in Table (16) showed that micro nutrient levels, application dates and their interaction had no significant effects on B content in sugar beet at harvest.

It was observed that very slight increases were found in B content particularly when B was applied alone or mixed with Zn and Mn. The results showed that roots of B treated plants contained from 11.70 to 14.10 ppm B compared with mean values form 9.50 and 9.80 ppm for the check plants.

It could be concluded that B application slightly increased B content in sugar beet roots.

Date of application did not significantly affect B content. The differences among B concentration values due to application date showed no specific trend.

The results obtained by Draycott and Holliday (1970) indicated that B concentration in sugar beet roots at harvest was 15 ppm, and in sugar beet leaves 40 ppm. The deficiency symptoms did not appear when B concentration was grater than 30 ppm, but deficiency symptoms appear when the concentration fell below 20 ppm in leaves.

Therefore, analysis of the check plants show clearly that the experimental soil contained adequate level of available B.

3- Zn content in leaves :

Results in Table (16) showed that the three micro nutrients did not significantly affect Zn content in sugar beet leaves at harvest. However, some considerable increases are observed in Zn content in leaves, particularly due to Zn applied alone or in the mixture.

The results showed that Zn concentration in leaves of Zn treated plants ranged between 22.20 and 31.10 ppm as against 13.10 - 15.60 ppm in the leaves of the check plants. These considerable increases show the response of sugar beet plants to the applied Zn.

Application date showed no significant effect on Zn content in leaves in spite of some slight increases observed at later application.

The interaction between levels and dates of applying micronutrients mixture had significant effect on Zn content in sugar beet root. The results indicated that the lower level of the mixture was more effective when applied after 90 days, whereas the higher level of the mixture showed higher effect when applied after 105 days. The highest Zn content in sugar beet roots was 33.30 ppm which was recorded by applying 1 kg B + 6 kg Zn + 40 g Mn/ fed at 105 days from planting.

The considerable effect of Zn application on Zn content did not reach the significant level probably due to the small number of replications devoted for the chemical analysis.

Results reported by Boawn and Viets (1956) indicated that Zn concentration of deficient leaves was 8 ppm while it was 13 ppm in healthy leaves.

Also, results reported by Rosell and Ulrich (1964) indicated that the critical level of Zn in sugar beet tissues was 9 - 10 ppm when plants were sampled after 6 weeks from planting.

Consequently, the Zn level in the experimental site was quite satisfactory to supply the sugar beet plants with their needs of Zn since the leaves of check plants contained more than the critical content.

4- Zn content in roots :

Results in Table (16) indicated that Zn applied or mixed with B and Mn at both application levels insignificantly increased Zn content in sugar beet roots at harvest.

The results revealed that Zn content in roots of sugar beet treated plants ranged between 15.20 and 18.80 ppm compared with 11.00 to 11.40 ppm for the check plants. These marked increases were however, below the level of significance.

The application of Zn significantly affected Zn content in roots. Application of the lower Zn level (3 kg/fed) at 90 days age was more effective on Zn content, whereas the higher Zn level (6 kg/ fed) was equally effective when applied after 90 or 105 days.

The interaction between Mn level and Mn application date significantly affected Zn content in roots. The highest Zn content was 15.30 ppm which was recorded with the higher Mn level applied either at 90 or 105 days.

It could be concluded that Zn content in sugar beet roots was favourably affected by the application of Zn either alone or mixed with B and Mn.

The results reported by Boawn and Viets (1956) revealed that Zn level of deficient leaves was 8 ppm and in healthy leaves it was 13 ppm. Consequently, the plants in the present study contained adequate Zn content.

The present results are in general agreement with those reported by Rutskaya *et al.* (1981).

5- Mn content in leaves :

Results in Table (16) showed that neither micro nutrient levels nor application dates significantly affected Mn content in sugar beet leaves at harvest. Also, the interaction level x date had no significant effect on Mn content in leaves.

The results show some increases in Mn content due to Mn application either in single or mixed application. The Mn content in leaves ranged between 28.80 and 34.40 ppm compared with 23.20 - 23.50 for the plants of the check treatment.

The results reported by Tsolova and Peneva (1992) showed that the greatest amount of Mn in sugar beet plants was 18.8 g/ ha, (equivalent to 7.9 g/ fed). The amount can be readily available in the experimental soil.

6- Mn content in roots :

Results in Table (16) showed that all experimental factors and their interaction did not significantly affect Mn content in sugar beet roots at harvest. The results here followed the same pattern of response as shown with Mn content in leaves. Insignificant increases in Mn content in sugar beet roots followed the application of Mn either singly of mixed with B and Zn.

Roots of sugar beet plants treated with Mn contained 22.40-23.70 ppm Mn compared with a range of 22.30- 22.90 ppm for the check plants.

Date of application of micro nutrients had no significant effect on Mn content in roots. Also, levels x dates of micro nutrients application did not significantly affect Mn content in roots. Generally, it was observed that slight increases in Mn content followed the later application of all nutrients and the increase in micro nutrients level.

This general trend could be detected from the results in Table (16), where the highest values of Mn content in roots were 21.50, 20.30, 25.00 and 24.80 ppm, which were recorded with the higher B,

Zn, Mn and B + Zn + Mn level combined with the latest application at 105 days age.

It could be concluded that micro nutrients in general and Mn in particular insignificantly increased Mn content in sugar beet roots at harvest.

The results obtained by Erjala (1986), Morsy and Taha (1986) as well as Last and Bean (1990) showed that Mn application increased Mn content in sugar beet tops and roots.

D- Yield Potentialities :

Root, Top and Sugar Yields of Sugar Beet as affected by Micro Nutrients :

Results for the effects of B, Zn, Mn and their mixture on root, top and sugar yields of sugar beet combined over 1993/ 94 and 1994/ 95 seasons are presented in Table (17).

D_1- Root yield :

Results in Table (17) showed that micro nutrients applied at three levels and at three different dates did not significantly affect root yield. However, insignificant increases were observed due to applying B, Zn, Mn and their mixture particularly at the higher level.

Results showed that applying B, Zn, Mn and their mixture at the lower levels insignificantly increased root yield by 11.96, 14.05, 8.68 and 11.04 %, compared with untreated sugar beet, respectively.

Table (17): Effect of Boron, Zinc, Manganese and their Mixture on root yield, top yield, and sugar yields of sugar beet (combined over two growing seasons, 1993/94 and 1994/95.)

Characters	Root yield (ton/fed) Application date (D)				Top yield (ton/fed) Application date (D)				Sugar yield (ton/fed) Application date (D)			
B, Zn, Mn and Mixture level	At Sowing	90 Days	105 days	Mean	At Sowing	90 Days	105 days	Mean	At Sowing	90 Days	105 days	Mean
0	29.10	30.10	31.10	30.10	6.60	7.10	7.60	7.10	4.30	4.70	5.10	4.70
B 0.5 kg/fed	33.30	33.90	34.03	33.70	8.10	8.60	9.10	8.60	5.30	5.50	5.60	5.50
1 kg/fed.	33.90	34.30	34.80	34.30	9.50	10.10	10.60	10.10	5.70	5.90	6.20	5.90
Mean	32.10	32.80	33.30	32.70	8.10	8.60	9.10	8.60	5.10	5.40	5.60	5.40
0	29.20	30.90	31.80	30.60	7.40	7.20	7.70	7.40	4.40	4.60	5.10	4.70
3 kg/fed	33.50	34.40	34.90	34.20	9.04	8.80	9.20	9.02	5.20	5.50	5.60	5.40
Zn 6 kg/fed.	33.60	33.80	34.70	34.0	8.90	9.60	9.60	9.40	5.40	5.70	6.01	5.70
Mean	32.10	32.90	33.80	32.90	8.50	8.50	8.80	8.60	4.90	5.30	5.50	5.30
0	30.40	31.30	31.60	31.10	6.90	6.90	7.10	7.02	4.50	4.70	5.10	4.80
20 g/fed	33.30	33.90	34.20	33.80	8.40	8.90	9.30	8.80	4.90	5.10	5.50	5.20
Mn 40 g/fed.	33.40	34.50	34.60	34.10	9.50	9.60	9.90	9.70	5.30	5.70	5.90	5.60
Mean	32.30	33.20	33.40	32.90	8.30	8.50	8.80	8.50	4.90	5.20	5.50	5.20
B + Zn + Mn												
0	30.03	30.90	31.50	30.80	6.80	7.00	7.50	7.10	4.60	4.60	5.00	4.70
0.5+3+0.02kg/fed.	33.90	34.40	34.40	34.20	8.30	8.40	9.20	8.60	5.40	5.60	5.80	5.60
1+6+0.04 kg/fed.	34.20	33.90	34.90	34.30	9.50	10.30	10.30	10.10	5.70	5.80	6.30	5..90
Mean	32.70	33.10	33.60	33.10	8.20	8.60	8.90	8.60	5.20	5.30	5.70	5.40
L.S.D at 0.05 level :												
B	N.S				N.S				N.S			
Application date	N.S				N.S				N.S			
B x D	N.S				N.S				N.S			
Zn	N.S				N.S				N.S			
Application date	N.S				N.S				N.S			
Zn x D	N.S				N.S				N.S			
Mn	N.S				N.S				N.S			
Application date	N.S				N.S				N.S			
Mn x D	N.S				N.S				N.S			
mixtures	N.S				N.S				N.S			
Application date	N.S				N.S				N.S			
mix. x D	N.S				N.S				N.S			

Applying B, Zn, Mn and their mixture at the higher levels , insignificantly increased root yield by 13.95, 11.21, 9.65 and 11.36 %, respectively compared with the control.

Date of application showed slight and insignificant increases due to delaying micro nutrients application. The application of B, Zn, Mn and their mixture after 90 days insignificantly increased root yield by 2.18, 2.49, 2.79 and 1.22 % compared with application at sowing, respectively.

Also, delaying the application of B, Zn, Mn and their mixture till 105 days slightly increased root yield by 3.74, 5.30, 3.41 and 2.75 % , respectively compared with application at sowing.

It could be concluded that soil application of micro elements favourably affected root yield resulting in yield increases ranging between 8.68 and 14.05 % compared with check plants. Later application is slightly better than early application at sowing.

The interaction between levels and dates of micro nutrients had no significant effects on root yield. However, it was observed that the highest yield was recorded by applying the higher level of the micro elements when applied at 105 days.

The insignificant results here are mainly due to the small number of replications.

The present results are mainly due to the effect of the applied micro nutrients on the growth and yield component characters. Results

reported by Stiles (1961), Shimilliar (1967), Omelchenko and Shadrina (1974), Krunic *et al.*, (1980), Roshina (1976), Vlasyuk *et al.*, (1974), Singh and Gangwar (1974), Kibalenko *et al.*, (1977), Voth (1978), Antoniv (1981), Morsy and Taha (1986), El- Mashhadi (1988) and Saif (1991) showed that B application increased root yield.

The positive effect on Zn on root yield was reported by Fuhering *et al.*, (1969), Zavrel (1978), Ljubic (1980), Lashkevich (1980), and Saif (1991).

The root yield response to Mn application was reported by Byasov (1972), Tuchashavili and Urtaev (1971), Chernova (1974), Vlasyuk *et al.*, (1974) Farley and Draycott (1976), and El-Sayed (1993).

The good effects of mixed application of micro nutrients were also reported by several investigators (Zolotov and Lavrov, 1973; Vlasyuk *et al.*, 1977; and Ljubic, 1980).

D_2- Top yield :

The response of top yield to micro elements followed the same pattern as that of root yield (Table 17).

Applying B, Zn, Mn, and their mixture at the lower level insignificantly increased top yield by 21.13, 21.89, 25.36 and 21.13 %, compared with the control, respectively.

Also, the application of the higher level of B, Zn, Mn and their mixture induced increases of 42.25, 27.03, 38.18 and 42.25 % over the check treatment, respectively.

It was clear that the greatest increase was produced by applying the higher level of B or the mixture. However, these marked increases were below the significant level due to the small number of replications. Date of application had no significant effect on top yield. However, some increases were produced due to the latest date, i.e. 105 days from planting. Applying B, Zn, Mn and their mixture after 105 days from planting insignificantly increased top yield by 12.35, 3.53, 6.02 and 8.54 %, respectively when compared with the control treatment.

The interaction between levels and dates of micro nutrients application had no significant effect on top yield. Although, the highest top yields were obtained by the highest micro elements levels combined with the latest application dates in all cases, being 10.60, 9.60, 9.90 and 10.30 tons/ fed, respectively for B, Zn, Mn, and their mixture.

It could be concluded that micro nutrients favourably affected top yield of sugar beet, although this result was not statistically ensured.

The results reported by Omelchenko and Shadrina (1974), Tadorcic and Faller (1977) and Saif (1991) indicated significant increase in top yield due to application of micro nutrients.

3- Sugar yield :

The results in Table (17) revealed that considerable increases were observed due to the application of micro nutrients, although these increases were below the level of significance.

The response of sugar yield is identical with those of root and top yields. Applying the lower levels of B, Zn, Mn and their mixture (0.5 kg B, 3 kg Zn, 20 g Mn/ fed and their mixture) insignificantly increased sugar yield by 17.02, 14.89, 8.33 and 19.15 %, respectively compared with the check treatment.

Also, the application of 1 kg B, 6 kg Zn, 40 g Mn/ fed and their mixture insignificantly raised sugar yield by 25.53, 21.28, 16.67 and 25.53 %, respectively compared with untreated plots. These marked increases were below the significant level.

Date of application had no significant effect on sugar yield in spite of some considerable increases in sugar yield due to the late application of the micro nutrients.

Delaying the application of B, Zn, Mn and their mixture from planting date to 105 days later insignificantly increased sugar yield by 9.80, 12.24, 12.24 and 9.62 %, respectively, with B, Zn, Mn and their mixture.

The interaction between levels and dates of micro nutrients application had no significant effect on sugar yield. Although, the highest sugar yield was the resultant of the higher micro nutrients

SUMMARY

Effect of some micro nutrients on yield and quality of sugar beet (*Beta vulgars L.*)

Field experiments were carried out in Sakha Agricultural Research Station, Kafr El- Sheikh Governaorate, in 1993/ 94 and 1994/ 95 seasons to study the effect of B, Zn, Mn and their mixture on growth, chemical content, juice quality and root and top yields of sugar beet (var. Ras-Ploy).

Each of the four experiments included 9 treatments which were the combination of 3 micro nutrient levels and three dates of application.

The first experiment included the following B levels: zero, 0.5 and 1.0 kg B/ fed. as sodium borate.

The second experiment included the following Zn levels: zero, 3 and 6 kg Zn/ fed. as zinc sulphate.

The third experiment included the following Mn levels : zero, 20 and 40 g/ fed, as manganese sulphate.

The fourth experiment included the mixture of the three nutrients (B + Zn + Mn) at the same levels mentioned before.

Dates of application with all micro nutrients were : at planting, after 95 days and after 105 days. Micro elements were applied only once as soil application.

The results of the combined analysis of the study could be summarized as follows :

I- Effects of Micro nutrients During Growth Stages :

1- B application level did not significantly affect number of leaves/ plant, LAI and top fresh weight/ plant at 135 and 165 days from planting.

2- Late application of B (at 90 or 105 days) significantly affected LAI compared with application at planting. This effect was observed in samples measured at 135 days age.

3- Top fresh weight at 105 days from planting was significantly affected by B level x application date interaction. B at 1 kg/ fed applied at 105 days produced the highest top fresh weight/ plant.

4- B application at the three levels had no significant effect on root length, root diameter and root fresh weight at 135, 150 and 165 days from planting.

5- Date of B application significantly affected root length and root fresh weight (at 135 days age), where B applied at 90 days positively affected these traits.

6- Date of B application significantly affected TSS % (at 150 days age). Late application of B showed positive effect on TSS % compared with B applied at sowing.

7- B application at the 3 levels did not significantly influence TSS %, sucrose % and purity % at the different growth periods.

8- Zn negatively affected number of leaves/ plant (at 150 days age) where a reduction in leaves number was recorded due to applying the highest Zn level (6 kg/ fed).

9- Zn application had no significant effects on LAI and top fresh weight throughout the growing seasons.

10- Late application of Zn (either at 90 or 105 days) positively affected LAI (at 165 days from planting).

11- Zn applied at 3 kg/ fed significantly increased root diameter (at 135 days from planting). On the other hand, root length and root fresh weight showed no response to Zn application throughout the growing season.

12- Zn level x application date significantly affected root length (at 135 days) and root fresh weight (at 165 days).

13- Early application of Zn positively affected root length (at 135 days) compared with later application.

14- Zn application reduced TSS % (at 165 days) compared with the check treatment. On the other hand, sucrose % and purity % were

not significantly affected by Zn level as well as Zn application date.

15- Mn application at different levels had no significant effect on number of leaves, LAI and top fresh weight at all growth stages. Also Mn application date did not significantly influence these traits.

16- Mn level x Mn application date showed significant effect on LAI (at 135 days) and top fresh weight/ plant (at 165 days).

17- Neither Mn level nor Mn application date had significant effect on root length, root diameter and root fresh weight/ plant throughout the growing season.

18- Mn application at 20 g/ fed reduced TSS % (at 135 days). Sucrose % as well as purity % were not affected by Mn application at all growth stages.

19- Mn level x Mn application date significantly affected sucrose % (at 165 days). The highest sucrose % was 14.55 % recorded by the latest application of the higher Mn level.

20- Applying a mixture of B + Zn + Mn at 1 + 6 + 0.04 kg/ fed reduced LAI (at 165 days) compared with the check treatment. On the other hand, the mixture of micro nutrients showed no any effect on number of leaves and top fresh weight/ plant at all growth stages.

21- Late application of the micro nutrients mixture showed positive effect on number of leaves/ plant (at 165 days age), but a negative effect for late application was observed on top fresh weight (at 135 days).

22- Root length, root diameter and root fresh weight were not significantly affected by micro nutrients mixture at all levels used.

23- Late application of the mixture showed better effect on root diameter (at 165 days), but negatively affected root fresh weight (at 135 days) compared with early application.

24- Neither level nor date of micronutrients mixture significantly affected TSS %, sucrose % and purity % throughout the growing season.

II- Effect of micro nutrients at harvest :

1- B application at 0.5 kg/ fed reduced TSS % at harvest, whereas Zn, Mn and the mixture showed no significant effect on TSS % .

2- All micro nutrients had no significant effect on sucrose % at harvest.

3- Mn application at 40 g/ fed significantly raised purity % at harvest.

4- Late application of micro nutrients mixture favourably affected purity % at harvest compared with early application.

5- Zn application particularly at the highest level significantly increased K % in leaves and roots of sugar beet at harvest.

6- The micro nutrients mixture increased N % in leaves at harvest when applied at the lower level.

7- Leaves content of B, Zn and Mn was not significantly affected by micro nutrients application.

8- Similarly root content of the three micro elements did not significantly respond to B, Zn and Mn application.

9- B application of the three micro elements at both levels did not significantly affect root, top and sugar yield of sugar beet. However, insignificant increases were observed in root, top and sugar yields due to micro nutrients. Root yield was increased by 13.95, 11.21, 9.65 and 11.36 % due to applying the higher level of B, Zn, Mn and their mixture, respectively.

10- Applying the higher level of B, Zn, Mn and their mixture insignificantly increased top yield by 42, 27, 38 and 42 % compared with the check treatment, respectively.

11- Also sugar yield was insignificantly increased by 25, 21, 16 and 25 % respectively due to B, Zn, Mn and B + Zn + Mn application.

12- The late application of micro elements particularly at 105 days from planting insignificantly increased yields of roots, tops and sugar.