Results and Discussion

RESULTS AND DISCUSSION

Before discussing the available obtained data it must be mentioned the following items:

1. It was thought advisable to discuses the obtained data of both experimental trials (seasons 1999-2000, and 2000-2001) as one unit, as the second trial treatments may be considered as an extension of the first ones, with some analogous treatments.
2. During the second experimental trial the used growth regulators concentration was extended to reach into 100 mg/l with exclusion of NAA as its physiological effects under the conditions of this work seemed to be limited, unlike to the other used growth regulators, i.e. GA_3 or B_9.
3. Also, the tested rates of both pollutant heavy metal were changed during the second course experimental trials, to be 0, 50 or 100 mg/l, instead of the using Cd or Pb at the rates of 0, 20 or 50 mg/l in the first experimental trials.

<u>Morphological measurement</u>

Morphological criteria in terms of root length, root diameter, percentage of root diameter/ root length and whole plant leaf area (cm^2 $plant^{-1}$) are tabulated in tables, 3, 4, 5, 6, 7, 8, 9 and 10. From these data it my be concluded on statistical analysis basis the following changes in morphological criteria as affected by the tested combined factors

1-It could be concluded that the tested two factors, i.e. the heavy metals (HM) and the growth regulators (GR) affected signify most of the parameters of morphological criteria. As a general, irrespective to any treatments, different morphological collected measurements increased gradually with advanced plant age, till reached into the maximum during

Table (3): Changes in root length (cm) of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3, NAA or B_9 levels (season 1999/2000).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	20	50	20	50	
		120 days after sowing					
Control	0	32.5	31.8	30.5	31.1	30.0	**31.2**
GA_3	50	32.7	34.0	30.8	31.8	31.2	**32.1**
NAA	50	32.7	32.2	31.3	31.6	30.0	**31.6**
B_9	50	32.5	33.3	33.0	31.5	30.0	**32.1**
Mean		**32.6**	**32.8**	**31.2**	**31.5**	**30.3**	**31.7**
L.S.D at 5%	H.M						**0.720**
	G.R						**0.644**
	H.M x G.R						**N.S**
		210 days after sowing					
Control	0	36.0	34.8	32.6	36.1	34.0	**34.7**
GA_3	50	39.6	39.9	38.7	37.5	36.3	**38.4**
NAA	50	35.5	32.8	31.5	36.7	36.0	**34.5**
B_9	50	35.5	36.3	32.4	32.8	31.7	**33.5**
Mean		**36.7**	**36.0**	**33.8**	**35.8**	**34.5**	**35.3**
L.S.D at 5%	H.M						**0.858**
	G.R						**0.768**
	H.M x G.R						**1.716**

Table (4): Changes in root length (cm) of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 or B_9 levels (season 2000/2001).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	24.1	22.3	19.2	21.8	20.0	**21.5**
GA_3	50	24.7	22.0	21.6	22.0	20.9	**22.2**
	100	27.1	21.6	23.0	26.6	24.0	**24.5**
B_9	50	26.0	24.3	21.6	25.0	22.6	**23.9**
	100	28.1	26.3	24.3	26.6	26.6	**26.4**
Mean		**26.0**	**23.3**	**21.9**	**24.4**	**22.8**	**23.7**
L.S.D at 5%	H.M						**0.606**
	G.R						**0.606**
	H.M x G.R						**1.213**
120 days after sowing							
Control	0	28.8	22.5	20.5	22.6	20.1	**22.9**
GA_3	50	30.0	27.0	25.0	24.6	22.0	**25.7**
	100	33.0	29.0	27.0	28.0	22.0	**27.8**
B_9	50	29.1	23.0	21.0	22.0	23.0	**23.6**
	100	28.1	25.0	23.0	27.0	25.0	**25.6**
Mean		**29.8**	**25.3**	**23.3**	**24.8**	**22.4**	**25.1**
L.S.D at 5%	H.M						**0.925**
	G.R						**0.925**
	H.M x G.R						**2.067**
210 days after sowing							
Control	0	34.4	32.3	29.5	31.0	26.3	**30.7**
GA_3	50	35.2	33.3	32.0	32.3	25.3	**31.6**
	100	38.0	35.0	33.6	34.0	28.0	**33.7**
B_9	50	34.0	35.3	30.3	31.0	31.0	**32.3**
	100	37.6	37.0	32.0	33.3	33.3	**34.6**
Mean		**35.8**	**34.6**	**31.5**	**32.3**	**28.8**	**32.6**
L.S.D at 5%	H.M						**1.476**
	G.R						**1.476**
	H.M x G.R						**3.301**

Table (5): Changes in root diameter (cm) of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3, NAA or B_9 levels (season 1999/2000).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	20	50	20	50	
120 days after sowing							
Control	0	15.5	15.1	14.1	14.6	14.0	**14.7**
GA_3	50	16.0	15.0	14.1	16.0	15.3	**15.3**
NAA	50	16.0	15.3	14.1	14.0	13.8	**14.6**
B_9	50	16.8	16.8	15.9	15.0	14.6	**15.8**
Mean		**16.1**	**15.6**	**14.6**	**14.9**	**14.4**	**15.1**
L.S.D at 5%	**H.M**						**0.491**
	G.R						**0.439**
	H.M x G.R						**0.981**
210 days after sowing							
Control	0	20.5	19.6	18.7	19.6	18.9	**19.5**
GA_3	50	21.4	21.9	20.8	21.0	20.7	**21.2**
NAA	50	20.3	19.3	18.9	19.0	18.7	**19.2**
B_9	50	21.0	20.2	19.9	20.1	20.0	**20.2**
Mean		**20.8**	**20.3**	**19.8**	**19.9**	**19.6**	**20.0**
L.S.D at 5%	**H.M**						**0.443**
	G.R						**0.396**
	H.M x G.R						**N.S**

Table (6): Changes in root diameter (cm) of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 or B_9 levels (season 2000/2001).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	10.0	9.6	9.0	10.3	9.6	**9.7**
GA_3	50	10.5	10.0	9.6	10.3	10.0	**10.1**
	100	11.8	11.0	11.0	11.3	11.2	**11.3**
B_9	50	11.6	10.6	10.0	12.0	9.3	**10.7**
	100	12.1	11.2	10.6	12.0	9.3	**11.0**
Mean		**11.2**	**10.5**	**10.0**	**11.2**	**9.9**	**10.6**
L.S.D at 5%	H.M						**0.287**
	G.R						**0.287**
	H.M x G.R						**0.642**
120 days after sowing							
Control	0	14.6	14.0	12.9	13.9	13.6	**13.8**
GA_3	50	15.2	14.1	13.7	15.0	13.9	**14.4**
	100	17.1	15.2	15.0	15.5	14.1	**15.4**
B_9	50	15.4	13.9	14.1	15.3	15.0	**14.7**
	100	16.1	15.8	15.5	16.1	15.8	**15.9**
Mean		**15.7**	**14.6**	**14.2**	**15.2**	**14.5**	**14.8**
L.S.D at 5%	H.M						**0.379**
	G.R						**0.379**
	H.M x G.R						**0.846**
210 days after sowing							
Control	0	20.3	18.8	18.0	19.7	18.6	**19.1**
GA_3	50	21.3	20.6	20.3	19.3	21.3	**20.6**
	100	22.6	22.0	20.3	21.6	23.3	**22.0**
B_9	50	22.3	20.2	20.6	21.3	20.0	**20.9**
	100	23.5	22.0	22.6	23.0	21.4	**22.5**
Mean		**22.0**	**20.7**	**20.4**	**20.9**	**20.9**	**21.0**
L.S.D at 5%	H.M						**0.401**
	G.R						**0.401**
	H.M x G.R						**0.897**

Table (7): Changes in the proportion of root diameter / root length (as %) of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3, NAA or B_9 levels (season 1999/2000).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	20	50	20	50	
120 days after sowing							
Control	0	47.7	47.5	46.2	46.6	46.7	**46.9**
GA_3	50	48.9	44.1	45.8	50.3	49.0	**47.6**
NAA	50	48.9	47.5	44.9	44.3	46.0	**46.3**
B_9	50	51.7	50.4	48.2	47.8	48.7	**49.4**
Mean		**49.3**	**47.4**	**46.3**	**47.3**	**47.6**	**47.6**
210 days after sowing							
Control	0	56.9	56.3	57.4	54.3	55.6	**56.1**
GA_3	50	54.0	54.9	53.7	56.0	57.0	**55.1**
NAA	50	57.2	58.8	60.0	51.8	51.9	**55.9**
B_9	50	59.2	55.6	61.4	61.3	63.1	**60.1**
Mean		**56.7**	**56.4**	**58.1**	**55.9**	**56.9**	**56.8**

Table (8): Changes in the proportion of root diameter/root length (as%) of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 or B_9 levels (season 2000/2001).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	41.5	43.0	46.9	47.2	48.0	**45.3**
GA_3	50	42.5	45.5	44.4	46.8	47.8	**45.4**
	100	43.5	50.9	47.8	42.5	46.7	**46.3**
B_9	50	44.6	43.6	46.3	48.0	41.2	**44.7**
	100	43.1	42.6	43.6	45.1	35.0	**41.9**
Mean		**43.0**	**45.1**	**45.8**	**45.9**	**43.7**	**44.7**
120 days after sowing							
Control	0	50.7	62.2	62.9	61.5	69.9	**61.4**
GA_3	50	50.7	52.2	54.8	60.9	63.2	**56.4**
	100	51.8	52.4	55.6	55.4	64.1	**55.9**
B_9	50	53.1	60.4	67.1	69.5	60.9	**62.2**
	100	53.5	63.0	67.4	59.6	63.2	**61.3**
Mean		**51.9**	**58.0**	**61.6**	**61.4**	**64.3**	**59.4**
210 days after sowing							
Control	0	59.0	58.2	61.0	62.5	70.7	**62.3**
GA_3	50	60.5	61.9	63.4	59.8	84.2	**66.0**
	100	59.5	62.9	60.4	63.5	83.2	**65.9**
B_9	50	65.6	57.2	68.0	68.7	64.5	**64.8**
	100	62.5	59.5	70.6	69.1	64.3	**65.2**
Mean		**61.4**	**59.9**	**64.7**	**64.7**	**73.4**	**64.8**

Table (9) Changes in whole plant leaf area (cm^2) of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3, NAA or B_9 levels (season 1999/2000).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	20	50	20	50	
120 days after sowing							
Control	0	7205.0	6246.0	5096.0	7214.0	6514.0	**6455.0**
GA_3	50	9423.0	8436.0	7776.0	9320.0	8702.0	**8731.4**
NAA	50	6957.0	6336.0	5430.0	6630.0	6351.0	**6340.8**
B_9	50	8433.0	6798.0	6138.0	8853.0	8550.0	**7754.4**
Mean		**8004.5**	**6954.0**	**6110.0**	**6754.3**	**7529.3**	**7320.4**
L.S.D at 5%	H.M						13.694
	G.R						12.248
	H.M x G.R						27.388
210 days after sowing							
Control	0	9230.0	8596.0	7542.0	9837.0	9157.0	**8872.4**
GA_3	50	11661.0	10458.0	10532.0	11295.0	10956.0	**10981.0**
NAA	50	10683.0	9072.0	8480.0	11250.0	10542.0	**10005.4**
B_9	50	10938.0	10320.0	9828.0	10332.0	10000.0	**10283.0**
Mean		**10128.0**	**9611.5**	**9696.3**	**10678.5**	**10163.8**	**10035.5**
L.S.D at 5%	H.M						10.584
	G.R						9.466
	H.M x G.R						21.167

Table (10): Changes in whole plant leaf area (cm^2) of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 or B_9 levels (season 2000/2001).

Heavy Metal (HM) (mg/l) / Growth Regulator (G.R)(mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	2636	2340	2324	2597	2308	**2441.0**
GA_3	50	3585	3288	2541	3275	2560	**3049.8**
	100	4174	3336	3048	3640	2751	**3389.8**
B_9	50	2882	2340	2260	2660	2432	**2514.8**
	100	3375	2625	2142	3036	2489	**2733.4**
Mean		**3330.4**	**2785.8**	**2463.0**	**3041.6**	**2508.0**	**2825.8**
L.S.D at 5%	**H.M**						**8.757**
	G.R						**8.757**
	H.M x G.R						**19.582**
120 days after sowing							
Control	0	7594	5546	5054	6385	5451	**6006.0**
GA_3	50	9173	6000	5713	7425	5713	**6804.8**
	100	9966	6784	5970	8676	5940	**7467.2**
B_9	50	8623	6567	6150	8160	6633	**7226.6**
	100	9322	7260	6752	8480	7585	**7879.8**
Mean		**8935.6**	**6431.4**	**5927.8**	**7825.2**	**6264.4**	**7076.9**
L.S.D at 5%	**H.M**						**83.60**
	G.R						**83.60**
	H.M x G.R						**186.96**
210 days after sowing							
Control	0	9543	8706	7335	9861	8611	**8811.2**
GA_3	50	10475	9320	8208	9600	9870	**9494.6**
	100	10960	10290	8778	11000	10164	**10238.4**
B_9	50	10869	9890	7980	9080	9061	**9376.0**
	100	11908	10848	8284	10626	9600	**10253.2**
Mean		**10751.0**	**9810.8**	**8117.0**	**10033.4**	**9461.2**	**9634.7**
L.S.D at 5%	**H.M**						**19.40**
	G.R						**19.40**
	H.M x G.R						**43.38**

the harvesting stage (210 days after sowing), during both successive seasonal trials.

2-Limiting seasonal variations in growth morphological criteria were observed between plants grown under the variation of environmental conditions of both trials. As a general, morphological criteria, and irrespective to any treatments, sugar beet plants grown under the conditions of the first seasonal trials was relatively and mostly higher than those corresponding one: grown under second ones.

3-With regard to the effects of the tested heavy metals irrespective to other treatments with the examined growth regulators, it may concluded that their final physiological phytotoxicity expressions were exhibited on the morphological growth retardation. These retardation effects increased mostly with increasing their rate of foliar application. In this respect, it was worthy to mentioned here that, (**Lanaras *et al.*, 1993),** concluded that Cd or Pb are strongly phytotoxic. Pollution by these metals causes growth inhibition, they become extremely toxic to cells and can ultimately cause the death of plants. **(Steffens, 1990 and Verkleij and Schat, 1990).** The term " toxic concentration" is use in the literature for a heavy metal concentration that significantly inhibits metabolic activity and retard partially plant growth without inducing plant death (**Lanaras *et al.*, 1993).** Intact plants, which are exposed to this concentration stay alive, but with, decreased growth and slower development **(Clijsters and Van Assche, 1985).**

According to these definitions of the phytotoxicity of the tested heavy metals different used concentrations of Cd or Pb applied twice as foliar sprays to the foliage leaves of sugar beet plants are considered as phytotoxic, as these concentrations retard morphological sugar beet plant growth. The lower the used concentration of Cd or Pb, the lower the retardation effects was gained. In other words, the used rates of Cd or Pb were under the lethal concentration, as sugar beet plants can stay alive when exposed to the stress conditions of foliar spray with 100 mg/l Cd or Pb, applied twice (the highest used rate under this study).

4-With regard to the morphological growth response of sugar beet plant to the foliar application of the examined growth regulators in the absence of heavy metals treatments, it may concluded that GA_3 seemed to have slight increasing effects on root length, and root diameter. This effect increased with increasing its rate. However, the other tested growth regulators, seemed to have mostly limiting retardation effects on such morphological parameters.

On the other hand, most of the tested growth regulators, seemed to have stimulatory effects on photosynthetic area (Whole plant leaf area). The most obvious one in this respect seemed to be gained under the use of GA_3 at the first seasonal trial, and B_9 during the second one. This may be discussed on the basis that prevailing environmental conditions interacted with the growth regulator actions. NAA seemed to have the least effect in this respect.

5-With regard to the interpretation effects of Cd or Pb with GA_3, NAA or B_9 ,it could be concluded that most rates of the growth regulators checked with variable degree the retarding growth effects of the tested heavy metals. In this connection, **Abd El-Hamid *et al.* (1992, a & b)** concluded that many growth regulators were used to control plant growth and hence enable plants to tolerate the stress conditions. In other words, the tested growth regulators under the conditions of this work seemed to have partial detoxification action of Cd or Pb.

The partial detoxification action, seemed to be gained by using GA_3 or B_9 . The higher the rate of GA_3 or B_9 the higher the plant tolerance to heavy metal stress, without clear trends between both used growth regulators. This action of growth regulators as partial antitoxification agency of Cd or Pb seemed to be affected by the prevailing environmental conditions, and the age of the plant, without clear trends in this respect, with regard to the used rates of growth regulator x levels of Cd or Pb.

6- With regards to the changes of the percentage ratio of root diameter / root length, it may be concluded that, as general, and irrespective to any treatments, this ratio increased with advantage plant age, (Tables 7&8). This may be discussed on the bases that root growth in the diameter exceeded its growth in length during different periods of growth, i.e. the root become more thicken during its developing stages. In other words, the root growth in length began faster than in thickness, then the *vice versa* occurred during the later periods of growth, and that may be connected with the changes in the root functions, as its main function during later periods seemed to be as storage organ. The different treatments affected slightly the relationship between the root diameter / root length ratio. However, some changes in this ratio could be observed with different treatments. This means that the phytotoxicity of heavy metals may be extended to the storage processes, which could be regulated by the tested growth regulators.

7- In spite of the limiting variation between the harmful effects of Cd and Pb on root length and root diameter, however, the ratio of root diameter / root length was relatively higher when sugar beet plant subjected under the stress of Pb as compared to those of the corresponding ones of Cd, during most different periods of growth.

8- Finally, one can concluded that the most obvious regulatory effects on morphological parameters, of the tested heavy metals, or the used growth regulators and the combinations between them, seemed to be on photosynthetic area. The most harmful effect of heavy metals was gained by Cd than Pb in this respect. While GA_3 may be exhibited the most stimulatory effects in this respect,even under depressive combined effects of heavy metals. However, most used growth regulators minimized the inhibitory effects of Cd or Pb on the functional photosynthetic area.

Ratio between root diameter / root length:

In general, the rate of root growth in length was higher than its growth in diameter at beginning. As the plants develop the rate of root diameter increment was relatively more than the increase in length. Such pattern was reflected on root diameter / length ratio. However, the ratio gradually increased during the successive periods. This trend, as general may be related partially to the translocation of the photosynthesized organic compounds from aerial leaves to the storage root. In addition, plants directed their efforts to the root length during the early periods of growth, as the main function of root are the uptake of water and nutrient mineral during the early periods of growth. Thereafter, during the later periods of growth, plants directed their efforts to the growth of roots in diameter than in length, as the main functions of root are the uptake of water and nutrient minerals. Thereafter, during the later periods of growth, plants directed their efforts to the growth of roots in diameter than in length.as beside water and mineral uptake, preserved organic matter accumulated in such storage tuberous root increased continuously till it reached into the maximum during harvesting stage (210 days after sowing). Such period is distinguished by the growth of the storage organ in volume more than in length, i.e. the root become more swelling in shape.

As mentioned before, the tested treatments of Cd or Pb and the used growth regulators rates as well as interactions between them affected the root length and its diameter. These regulatory effects extended to include the grade of swelling shape of roots during different periods of growth. Under lead treatments the sugar beet root seemed to be mostly more swelling, than those corresponding ones of Cd especially during the late period of growth. This may be discussed on the basis that Pb seemed to be have a regulatory effects on the presses of storage mechanism. In addition, the regulatory effects of the tested growth regulators seemed to be more obvious in the presence of lead treatments than those corresponding ones of Cd treatments, especially GA_3 treatments, during the second experimental trials.

In this respect, **Miseha *et al.* (1992)** working on fodder beet plant, showed that GA_3 and Alar regulated the translocation of reserved food by many ways according to their used rates. They also concluded that GA_3 or Alar concentration slightly stimulated the root diameter / length ratio compared with control.

It must be mentioned that the prevailing environmental factors seemed to be interacted with the effects of the growth regulators, and their interactions with Cd or Pb phytotoxicity on the shape of root and hence the reserve food translocation from the denotors into the receptors. As a general, the root shape seemed to be more swollen during the second experimental trials than those corresponding ones of the first trials.

Accordingly, and from the foregoing results, it was suggested that Cd or Pb treatments affected partially root growth with some variable degree, as a part of their phytotoxification on plant growth processes. In addition, it may be assumed that different treatments with the tested growth regulators could regulated this phytotoxification with some degree. However, the environmental conditions seemed to be have a regulatory effects on the toxi-and detoxification actions heavy metal-growth regulators correlation.

Growth parameters and Growth analysis:

Before discussing the quantitative growth analysis, it is thought advisable to mention the following considerations as reported by **Abd El-Hamid and El-Nabarawy (2001),** as they concluded that:

1) Growth can be measured by variety of ways, either as absolute values (actual amounts) or as "relative calculation amounts".

2) The relative or proportion measurements in plant growth as a whole or in its individual organ may be more suitable to explain the growth process than the use of the actual absolute values.

3) Leaf area is used to assess plant growth in a system growing in two dimensions, such as expanding leaf, i.e. the functional photosynthetic area. This area must be connected with either new leaves formation and /or individual leaf expansion, but death or loss of the leaves may be affected the whole plant leaf area.

4) Dry matter content is the better indication of growth in different plant organs, as well the whole plant itself.

5) Also, **Abd El-Hamid and El-Nabarawy (2001),** concluded that, there is no doubt that the functional photosynthetic area must be correlated and control plant growth, development and differentiation, that the ratio between different plant organs formation may bring a vast of possibilities for exploring the growth pattern under any conditions of treatments, and the efficiency of the plant as a producer of new material which termed by them as the "efficiency index" of dry weight production. The higher the proportional dry matter accumulation in different plant organs, the higher the "efficiency index" obtained. The "efficiency index" , is clearly dependent upon the rate of leaf area. Therefore, as the plant growth and increases its leaf area, the rate at which new material is assimilated well increase proportionally. According, the ratio between plant-leaf-area and whole plant growth,or individual plant organ dry weight development, could be used for exploring the nature of growth pattern of the plant, under variable conditions (stress or not). They termed these proportional parameters between plant organs as the coordination and correlation between different plant organs which must be surfed or affected the growth and

morphogenesis of the plant and its growth habit under variable condition.

According to the aforementioned information, it was thought advisable to discussed the growth habit of sugar beets grown under the stress conditions of foliar sprays with specific rates of either Cd or Pb in relations to the foliar applications of some growth regulators, with hopeful to get some clue information about the phytotoxicity of the used heavy-non essential-soft-heavy-pollutant elements, or in trial to minimizing their harmful effects. Our explanation depended partially upon the "actual absolute parameters" of fresh and dry weights of different plant organs as well as whole plant with brief in details. In addition, some proportional correlation's coordination between plant organs in terms of the percentage distribution of dry matter in root as related to the whole amounts in plant, as well as "leaf area ratio" (LAR), leaf weight ratio (LWR) and specific leaf area (SLA) were calculated. Also, the percentage of dry weight as related to fresh weight of roots to explore indirect the water status in roots, in addition to the water balance in leaf tissues as mg/cm^2 (mg per unit leaf area), as the water balance in plant tissues must be have a role in controlling plant growth,

1-Absolute actual amounts of fresh and dry weights:

The data of fresh weight of roots, shoots and whole plant (g/plant) was tabulated in (Tables 11,12,13,14,15 and 16). While the data of dry weight in different sugar beet plant organs and whole plant were tabulated in (Tables, 17,18,19,20,21 and 22) as g/plant.

From these data it may concluded the following conclusion:

1-As it was shown in morphological growth criteria, i.e. root length and its diameter, and leaf area, the continuous increase in plant organ fresh and dry weights were also observed with advancing plant age. Accordingly, it may be assumed that suger beet plant may be

Table (11): Changes in root fresh weight (g)/plant of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3, NAA or B_9 levels (season 1999/2000).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	20	50	20	50	
120 days after sowing							
Control	0	756.2	744.0	731.1	736.4	728.8	**739.3**
GA_3	50	791.3	798.8	784.6	772.1	765.5	**782.5**
NAA	50	751.7	743.9	719.0	738.2	730.0	**736.6**
B_9	50	744.0	774.6	762.3	754.1	745.0	**756.0**
Mean		**760.8**	**765.3**	**749.3**	**750.2**	**742.3**	**753.6**
L.S.D at 5% H.M							2.505
G.R							2.240
H.M x G.R							5.010
210 days after sowing							
Control	0	1092.1	1077.1	1054.5	1080.1	1065.9	**1073.9**
GA_3	50	1184.2	1160.0	1149.9	1182.5	1178.9	**1171.1**
NAA	50	1102.2	1100.3	1094.1	1067.8	1056.2	**1084.1**
B_9	50	1125.1	1133.3	1126.7	1084.0	1071.8	**1108.2**
Mean		**1125.9**	**1117.7**	**1106.3**	**1103.6**	**1093.2**	**1109.3**
L.S.D at 5% H.M							5.276
G.R							4.719
H.M x G.R							10.552

Table (12): Changes in root fresh weight (g)/plant of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 or B_9 levels (season 2000/2001).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	311.0	287.7	262.7	295.8	285.7	**288.6**
GA_3	50	414.9	315.7	310.7	337.3	317.0	**339.1**
	100	445.0	336.0	326.7	433.0	390.3	**386.2**
B_9	50	330.3	320.3	281.0	311.4	308.2	**310.2**
	100	341.2	325.7	310.7	325.3	316.3	**323.8**
Mean		**368.5**	**317.1**	**298.4**	**340.6**	**323.5**	**329.6**
L.S.D at 5%	H.M						10.662
	G.R						10.662
	H.M x G.R						23.841
120 days after sowing							
Control	0	780.3	756.9	684.4	763.1	727.6	**742.5**
GA_3	50	828.1	785.5	710.3	808.0	772.0	**780.8**
	100	844.7	798.3	724.0	834.0	813.0	**802.8**
B_9	50	790.0	745.0	708.0	766.1	745.0	**750.8**
	100	806.0	759.0	715.0	781.3	756.0	**763.5**
Mean		**809.8**	**768.9**	**708.3**	**790.5**	**762.7**	**768.1**
L.S.D at 5%	H.M						6.658
	G.R						6.658
	H.M x G.R						14.891
210 days after sowing							
Control	0	1183.7	1146.5	1114.5	1166.0	1138.5	**1149.8**
GA_3	50	1213.8	1185.0	1154.0	1198.0	1180.0	**1186.2**
	100	1260.3	1230.0	1202.0	1231.0	1195.0	**1223.7**
B_9	50	1195.1	1145.0	1127.0	1188.0	1163.2	**1163.7**
	100	1213.1	1181.0	1139.0	1266.0	1180.0	**1195.8**
Mean		**1213.2**	**1177.5**	**1147.3**	**1209.8**	**1171.3**	**1183.8**
L.S.D at 5%	H.M						10.082
	G.R						10.082
	H.M x G.R						22.540

Table (13): Changes in leaf fresh weight (g)/plant of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3, NAA or B_9 levels (season 1999/2000).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	20	50	20	50	
120 days after sowing							
Control	0	597.0	591.0	568.0	594.0	580.0	**586.0**
GA_3	50	616.0	600.0	585.0	618.0	608.0	**605.4**
NAA	50	608.0	590.0	578.0	603.0	595.0	**594.8**
B_9	50	618.0	618.0	597.0	619.0	603.0	**611.0**
Mean		**609.8**	**599.8**	**582.0**	**608.5**	**596.5**	**599.3**
L.S.D at 5%	H.M						6.375
	G.R						5.702
	H.M x G.R						N.S
210 days after sowing							
Control	0	999.0	995.0	960.0	998.0	977.0	**985.8**
GA_3	50	1083.0	1053.0	1038.0	1075.0	1071.0	**1064.0**
NAA	50	1048.0	1011.0	985.0	1035.0	1030.0	**1021.8**
B_9	50	1083.0	1079.0	1055.0	1063.0	1058.0	**1067.6**
Mean		**1053.2**	**1034.5**	**1009.5**	**1042.7**	**1034.0**	**1034.8**
L.S.D at 5%	H.M						6.489
	G.R						5.803
	H.M x G.R						12.978

Table (14): Changes in leaf fresh weight (g)/plant of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 or B_9 levels (season 2000/2001).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	458	412	386	434	412	**420**
GA_3	50	507	476	428	487	467	**473**
	100	538	489	402	499	485	**483**
B_9	50	483	426	403	454	409	**435**
	100	486	445	416	440	420	**441**
Mean		**494**	**450**	**407**	**463**	**439**	**450**
L.S.D at 5%	H.M						8.680
	G.R						8.680
	H.M x G.R						19.41
120 days after sowing							
Control	0	620	571	525	620	624	**592**
GA_3	50	644	591	551	631	618	**607**
	100	656	602	568	641	640	**621**
B_9	50	635	579	535	650	668	**613**
	100	641	590	557	667	670	**625**
Mean		**639**	**587**	**547**	**642**	**644**	**612**
L.S.D at 5%	H.M						6.559
	G.R						6.559
	H.M x G.R						14.66
210 days after sowing							
Control	0	1024	967	879	1006	989	**973**
GA_3	50	1048	972	887	1031	1029	**993**
	100	1086	986	881	1062	1043	**1011**
B_9	50	1041	990	963	1020	1001	**1003**
	100	1064	1027	977	1045	1033	**1029**
Mean		**1053**	**989**	**917**	**1033**	**1019**	**1002**
L.S.D at 5%	H.M						17.77
	G.R						17.77
	H.M x G.R						39.74

Table (15): Changes in whole plant fresh weight (g)/plant of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3, NAA or B_9 levels (season 1999/2000).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	20	50	20	50	
120 days after sowing							
Control	0	1347.9	1328.0	1299.1	1332.4	1308.0	**1323.1**
GA_3	50	1406.3	1385.3	1369.6	1405.0	1373.5	**1387.9**
NAA	50	1359.0	1333.9	1297.0	1343.2	1325.0	**1331.6**
B_9	50	1390.0	1392.6	1359.3	1373.1	1348.0	**1372.6**
Mean		**1375.8**	**1360.0**	**1331.3**	**1363.4**	**1338.6**	**1353.8**
210 days after sowing							
Control	0	2088.1	2072.1	2018.5	2078.1	2037.3	**2058.8**
GA_3	50	2266.1	2213.0	2187.9	2257.5	2249.9	**2234.9**
NAA	50	2148.1	2111.3	2079.1	2102.8	2086.2	**2105.5**
B_9	50	2206.8	2221.3	2181.7	2146.5	2129.8	**2177.2**
Mean		**2177.3**	**2154.4**	**2116.8**	**2146.2**	**2125.8**	**2144.1**

Table (16): Changes in whole plant fresh weight (g)/plant of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 or B_9 levels (season 2000/2001).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	765.8	701.3	650.7	726.3	696.7	**708.2**
GA_3	50	917.5	791.7	738.7	824.3	784.0	**811.2**
	100	988.3	825.0	728.7	932.0	875.3	**869.9**
B_9	50	811.3	746.3	684.0	765.4	717.2	**744.8**
	100	828.2	770.7	726.7	765.3	736.3	**765.4**
Mean		**862.2**	**767.0**	**705.8**	**802.7**	**761.9**	**779.9**
120 days after sowing							
Control	0	1408.3	1344.0	1213.7	1389.0	1348.5	**1340.7**
GA_3	50	1469.1	1376.5	1261.3	1439.0	1390.0	**1387.2**
	100	1499.1	1400.3	1292.0	1475.0	1453.0	**1423.9**
B_9	50	1424.3	1324.0	1243.0	1416.1	1413.0	**1364.1**
	100	1442.4	1349.0	1272.0	1448.3	1426.0	**1387.5**
Mean		**1448.6**	**1358.8**	**1256.4**	**1433.5**	**1406.1**	**1380.7**
210 days after sowing							
Control	0	2208.0	2120.0	1995.0	2169.0	2124.0	**2123.2**
GA_3	50	2259.7	2157.0	2041.0	2229.0	2209.0	**2179.1**
	100	2350.6	2216.0	2083.0	2293.0	2238.3	**2236.2**
B_9	50	2235.0	2135.0	2090.0	2208.0	2164.0	**2166.4**
	100	2274.0	2208.0	2116.0	2311.0	2213.0	**2224.4**
Mean		**2265.5**	**2167.2**	**2065.0**	**2242.0**	**2189.7**	**2185.9**

Table (17): Changes in root dry weight (g)/plant of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3, NAA or B_9 levels (season 1999/2000).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	20	50	20	50	
		120 days after sowing					
Control	0	145.2	140.1	137.4	137.9	131.9	**138.5**
GA_3	50	161.1	160.5	155.9	151.0	149.9	**155.1**
NAA	50	146.9	148.7	130.0	129.4	119.8	**135.0**
B_9	50	157.4	158.3	151.7	145.0	140.1	**150.5**
Mean		**152.7**	**151.9**	**143.8**	**140.8**	**134.7**	**144.8**
L.S.D at 5%	**H.M**						**0.543**
	G.R						**0.486**
	H.M x G.R						**1.086**
		210 days after sowing					
Control	0	236.3	230.2	218.6	227.3	227.7	**228.0**
GA_3	50	278.9	246.6	239.5	264.5	253.5	**256.6**
NAA	50	245.1	231.7	208.8	245.2	230.0	**232.2**
B_9	50	260.7	242.6	236.3	250.5	244.9	**247.0**
Mean		**255.3**	**237.8**	**225.8**	**246.9**	**239.0**	**240.9**
L.S.D at 5%	**H.M**						**1.426**
	G.R						**1.275**
	H.M x G.R						**2.852**

Table (18): Changes in root dry weight (g)/plant of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 or B_9 levels (season 2000/2001).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	64.4	53.1	48.2	53.1	51.3	**54.0**
GA_3	50	82.5	60.3	57.6	65.4	60.2	**65.2**
	100	91.0	67.2	65.3	85.7	75.8	**77.0**
B_9	50	65.6	64.1	53.1	61.8	59.2	**60.7**
	100	71.4	67.1	60.9	64.7	61.8	**65.2**
Mean		**75.0**	**62.4**	**57.0**	**66.1**	**61.7**	**64.4**
L.S.D at 5%	**H.M**						**1.456**
	G.R						**1.456**
	H.M x G.R						**3.252**
120 days after sowing							
Control	0	155.4	151.1	134.9	142.0	134.0	**143.5**
GA_3	50	169.6	157.1	143.5	155.1	146.7	**154.4**
	100	180.1	170.0	152.0	171.8	162.6	**167.3**
B_9	50	161.6	155.7	140.2	151.7	149.0	**151.6**
	100	175.1	160.9	150.2	157.8	152.0	**159.2**
Mean		**168.4**	**159.0**	**144.2**	**155.7**	**148.9**	**155.2**
L.S.D at 5%	**H.M**						**1.634**
	G.R						**1.634**
	H.M x G.R						**3.655**
210 days after sowing							
Control	0	266.0	248.2	228.0	251.8	228.0	**244.4**
GA_3	50	283.1	269.0	253.9	281.5	254.9	**268.5**
	100	304.8	295.2	264.4	295.4	276.0	**287.1**
B_9	50	280.7	258.8	251.3	272.1	240.5	**260.6**
	100	298.9	271.6	256.3	302.6	269.0	**279.7**
Mean		**286.7**	**268.6**	**250.8**	**280.7**	**253.7**	**268.1**
L.S.D at 5%	**H.M**						**2.401**
	G.R						**2.401**
	H.M x G.R						**5.368**

Table (19): Changes in leaf dry weight (g)/plant of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3, NAA or B_9 levels (season 1999/2000).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	20	50	20	50	
		120 days after sowing					
Control	0	83.7	78.3	74.3	79.8	75.1	**78.2**
GA_3	50	91.8	83.9	82.4	86.5	77.3	**84.4**
NAA	50	83.3	80.2	74.1	80.2	77.3	**79.0**
B_9	50	90.8	82.8	80.3	85.4	83.0	**84.5**
Mean		**87.4**	**81.3**	**77.7**	**82.8**	**78.2**	**81.5**
L.S.D at 5%	**H.M**						**0.971**
	G.R						**0.869**
	H.M x G.R						**1.942**
		210 days after sowing					
Control	0	193.9	175.4	165.6	185.6	170.9	**178.3**
GA_3	50	226.7	203.9	171.4	207.4	201.5	**202.2**
NAA	50	209.6	185.0	172.3	198.7	187.6	**190.6**
B_9	50	219.5	207.4	195.3	210.4	209.4	**208.4**
Mean		**212.4**	**192.9**	**176.2**	**200.5**	**192.4**	**194.9**
L.S.D at 5%	**H.M**						**2.029**
	G.R						**1.815**
	H.M x G.R						**4.058**

Table (20): Changes in leaf dry weight (g)/plant of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 or B_9 levels (season 2000/2001).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	52.2	46.8	43.4	47.7	41.7	**46.4**
GA_3	50	56.4	54.0	53.6	56.0	49.4	**53.9**
	100	70.7	57.5	50.6	61.4	57.0	**59.4**
B_9	50	57.2	50.2	51.3	52.7	45.5	**51.4**
	100	58.1	53.1	54.0	51.9	47.9	**53.0**
Mean		**58.9**	**52.3**	**50.6**	**53.9**	**48.3**	**52.8**
L.S.D at 5%	H.M						**1.639**
	G.R						**1.639**
	H.M x G.R						**3.666**
120 days after sowing							
Control	0	87.8	74.5	65.7	83.0	79.9	**78.2**
GA_3	50	94.4	81.6	70.5	88.3	81.6	**83.3**
	100	101.0	85.5	77.2	89.7	88.3	**88.3**
B_9	50	90.8	77.0	69.6	89.7	90.8	**83.6**
	100	93.9	82.0	72.4	100.1	97.1	**89.1**
Mean		**93.6**	**80.1**	**71.1**	**90.2**	**87.5**	**84.5**
L.S.D at 5%	H.M						**1.796**
	G.R						**1.796**
	H.M x G.R						**4.017**
210 days after sowing							
Control	0	200.5	177.1	161.1	188.6	179.4	**181.3**
GA_3	50	216.4	183.7	157.8	198.9	182.9	**187.9**
	100	240.7	189.3	172.6	213.4	188.5	**200.9**
B_9	50	216.0	196.0	182.9	201.9	198.1	**199.0**
	100	237.3	208.4	188.5	210.0	216.9	**212.2**
Mean		**222.2**	**190.9**	**172.6**	**202.6**	**193.2**	**196.3**
L.S.D at 5%	H.M						**3.658**
	G.R						**3.658**
	H.M x G.R						**8.179**

Table (21): Changes in whole plant dry weight (g)/plant of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3, NAA or B_9 levels (season 1999/2000).

Heavy Metal (HM) (mg/l) / Growth Regulator (G.R)(mg/l)		Control	Cd		Pb		Mean
		0	20	50	20	50	
120 days after sowing							
Control	0	228.9	218.4	211.7	217.7	207.0	**216.7**
GA_3	50	252.9	244.4	235.3	237.5	224.2	**238.9**
NAA	50	230.2	228.9	204.1	209.6	203.1	**215.2**
B_9	50	248.2	241.1	232.0	230.4	223.1	**235.0**
Mean		**240.1**	**233.2**	**220.8**	**223.8**	**214.4**	**226.4**
210 days after sowing							
Control	0	430.2	405.6	384.2	412.9	398.6	**406.3**
GA_3	50	505.6	450.5	430.9	472.4	455.0	**462.9**
NAA	50	454.7	416.7	381.1	443.9	417.6	**422.8**
B_9	50	480.2	450.0	431.6	460.9	454.3	**455.4**
Mean		**467.7**	**430.7**	**407.0**	**447.5**	**431.4**	**436.8**

Table (22): Changes in whole plant dry weight (g)/plant of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 or B_9 levels (season 2000/2001).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	116.8	99.9	91.6	100.8	93.0	**100.4**
GA_3	50	138.9	114.3	111.2	121.4	109.6	**119.1**
	100	161.7	124.7	115.9	147.1	132.8	**136.4**
B_9	50	122.8	114.3	104.4	114.5	104.7	**112.2**
	100	129.5	120.2	114.9	116.6	109.7	**118.2**
Mean		**134.0**	**114.7**	**107.6**	**120.1**	**110.0**	**117.3**
120 days after sowing							
Control	0	243.0	225.6	200.6	225.0	213.9	**221.6**
GA_3	50	264.0	238.7	214.0	243.4	228.3	**237.7**
	100	281.1	255.5	229.2	261.5	250.9	**255.6**
B_9	50	252.4	232.7	209.8	241.4	239.8	**235.2**
	100	269.0	242.9	222.6	257.9	249.1	**248.3**
Mean		**261.9**	**239.1**	**215.2**	**245.8**	**236.4**	**239.7**
210 days after sowing							
Control	0	466.5	425.3	389.1	440.4	407.4	**425.7**
GA_3	50	499.5	452.7	411.7	480.4	437.8	**456.4**
	100	545.5	484.5	437.0	508.8	464.5	**488.1**
B_9	50	496.7	454.8	434.2	474.0	438.6	**459.7**
	100	536.1	480.0	454.8	512.6	485.9	**493.9**
Mean		**508.9**	**459.5**	**425.4**	**483.2**	**446.8**	**464.8**

Table (23): Changes in percentage distribution of dry weight in root as related to those found in whole plant of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3, NAA or B_9 levels (season 1999/2000).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	20	50	20	50	
		120 days after sowing					
Control	0	63.4	64.1	64.9	63.3	63.7	**63.9**
GA_3	50	63.7	65.7	65.0	63.6	65.5	**64.7**
NAA	50	63.3	65.0	63.7	61.7	61.9	**63.1**
B_9	50	63.7	65.7	65.4	62.9	62.8	**64.1**
Mean		**63.5**	**65.1**	**64.8**	**62.9**	**63.5**	**64.0**
		210 days after sowing					
Control	0	54.9	56.8	56.9	55.0	57.1	**56.2**
GA_3	50	55.2	54.7	55.6	56.0	55.7	**55.4**
NAA	50	53.9	55.6	54.8	55.2	55.1	**54.9**
B_9	50	54.3	53.9	54.7	54.4	53.9	**54.2**
Mean		**54.6**	**55.3**	**55.5**	**55.2**	**55.5**	**55.2**

Table (24): Changes in percentage distribution of dry weight, in roots to those found in whole plant, as of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 or B_9 levels (season 2000/2001).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	55.3	53.2	52.6	52.7	55.2	**53.8**
GA_3	50	59.4	52.8	51.8	53.9	54.9	**54.6**
	100	56.3	53.9	56.3	58.3	57.1	**56.4**
B_9	50	53.4	56.1	50.9	54.0	56.5	**54.2**
	100	55.1	55.8	53.0	55.5	56.3	**54.7**
Mean		**55.9**	**54.4**	**52.9**	**54.9**	**56.0**	**51.2**
120 days after sowing							
Control	0	63.9	67.0	67.2	63.1	62.6	**64.8**
GA_3	50	64.2	65.8	67.1	63.7	64.3	**65.0**
	100	64.1	66.5	66.3	65.7	64.8	**65.5**
B_9	50	64.0	66.9	66.8	62.8	62.1	**64.5**
	100	65.1	66.2	67.5	61.2	61.0	**64.9**
Mean		**64.3**	**66.5**	**67.0**	**63.3**	**63.0**	**64.9**
210 days after sowing							
Control	0	57.0	58.4	58.6	57.2	56.0	**57.4**
GA_3	50	56.7	59.4	61.7	58.6	58.2	**58.9**
	100	55.9	60.4	60.5	58.1	59.4	**58.9**
B_9	50	56.5	56.9	57.9	57.4	54.8	**56.7**
	100	55.8	56.6	56.4	59.0	55.4	**58.0**
Mean		**56.4**	**58.3**	**59.0**	**58.1**	**56.8**	**58.0**

considered as evergrowing plant, and that may be related partially to the continuos formations of photosynthetic compounds during different periods of growth.

2-Root fresh and dry weights were always higher than those corresponding ones of shoot system during different periods of growth.. Accordingly, the root system of sugar beet plant is considered as the more conspesious organ in this respect .

3-The differences in fresh and dry weights between the growing plants during the tested two seasons was expected as the prevailing environmental conditions play an important role in plant growth, development and differentiation .As a general, the root fresh weight was mostly higher in plants grown under second seasonal trial as compared to those corresponding ones grown under the first one especially during the later grown period. However, no clear trends could be observed with leaf fresh weight in this respect.

4-With regard to the variation of dry weights of different organs which related to the seasonal variations, it may be concluded that there was some variation without clear trend in this respect.

5-The retardation effects of Cd or Pb on morphological criteria were extended to include fresh and dry weights of sugar beet organs and whole plant as well. This retardation effect increased with increasing the used rates of both. The depressive effects of Cd or Pb on fresh and dry weights were shown in root and shoot systems as well as whole plant with variable degree, according to the tested organ and the prevailing environmental conditions, and the developing plant stage.

6-Sugar beet root system seemed to be relatively more sensitive to the phytotoxification of the pollutant elements than the shoot one , as the percentage of reduction effects of both tested metals were more or less higher in root system than in shoot one (the data is not presented) .

7-The reduction effects of the used trace non- essential-toxic- heavy metals on fresh weight and dry matter accumulation in different plant organs and whole plant, decreased partially by using the foliage applications of growth regulators. GA_3 seemed to be superior in this respect than the other tested growth regulators.

8- Cd seemed to be mostly have the harmful effects on plant growth than Pb,as the fresh and dry weight of different plant organs and whole plant were mostly higher under Pb treated plants , and without clear trends in this respects .

All of the previous discussed results may be clarified by the proportion distribution of dry matter in different plant organs (root and shoot systems) as related to the amounts found in whole plant.

Percentage distribution of dry matter in root:

Dry matter percentage distribution of dry matter in root system, was calculated as related to those found in whole plant. The data of percentage distribution in shoot system are not presented as the differences between those found in root and 100 are considered as the proportion found in shoot system (leaves, as the stem is very short and without conspicuous) proportion of shoot dry matter data are found under leaf weight ratio (LWR) which tabulated in Tables (25,26,27,28 and 29) It may be detected the following conclusions:

1) As a general, the proportion of dry matter accumulation in roots seemed to be more or less higher in root system than those corresponding ones in leaves during different periods of growth. In this connection, it may be concluded that root system of sugar beet plant as tuberous storage organ, supplied its dry matter contents from the donator functional photosynthetic organs, mainly as saccharose. Accordingly, it must be found coordination or correlation mechanisms between the dry matter donator organ and the receptor storage one.. This coordination mechanism

Table (25): Changes in leaf area ratio (LAR-cm^2/g), leaf weight ratio (LWR) and specific leaf area (SLA-cm^2/g) at 120 days after sowing as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3, NAA or B_9 levels (season 1999/2000).

Heavy Metal (HM) (mg/l) / Growth Regulator (G.R)(mg/l)		Control	Cd		Pb		Mean
		0	20	50	20	50	
		LAR (cm^2 /g)					
Control	0	31.48	28.60	24.07	33.14	31.47	**29.75**
GA_3	50	37.26	34.52	33.05	39.24	38.81	**36.58**
NAA	50	30.22	27.68	26.60	31.63	32.22	**29.67**
B_9	50	33.98	28.20	26.46	38.42	38.32	**33.08**
Mean		**33.24**	**29.73**	**27.55**	**35.61**	**35.21**	**32.27**
		LWR					
Control	0	0.3657	0.3587	0.3510	0.3665	0.3628	**0.3609**
GA_3	50	0.3630	0.3433	0.3485	0.3642	0.3448	**0.3528**
NAA	50	0.3619	0.3504	0.3630	0.3826	0.3922	**0.3700**
B_9	50	0.3658	0.3434	0.3461	0.3706	0.3720	**0.3596**
Mean		**0.3641**	**0.3490**	**0.3522**	**0.3710**	**0.3680**	**0.3608**
		SLA (cm^2/g)					
Control	0	86.08	79.77	68.59	90.40	86.38	**82.24**
GA_3	50	102.65	100.55	94.83	107.74	112.57	**103.67**
NAA	50	83.52	79.00	73.28	82.67	82.16	**80.13**
B_9	50	92.87	82.10	76.44	103.66	103.01	**91.62**
Mean		**91.28**	**85.36**	**78.29**	**96.12**	**96.03**	**89.41**

Table (26): Changes in leaf area ratio (LAR-cm^2/g), leaf weight ratio (LWR) and specific leaf area (SLA-cm^2/g) at 210 days after sowing as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3, NAA or B_9 levels (season 1999/2000).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	20	50	20	50	
LAR (cm^2/g)							
Control	0	21.45	21.19	19.63	23.82	22.97	**21.81**
GA_3	50	23.06	23.21	24.45	23.91	24.08	**23.74**
NAA	50	23.49	21.77	22.35	25.34	25.24	**23.64**
B_9	50	22.78	22.93	22.77	22.42	22.01	**22.58**
Mean		**22.70**	**22.28**	**22.30**	**23.87**	**23.58**	**22.94**
LWR							
Control	0	0.4507	0.4324	0.4310	0.4495	0.4287	**0.4385**
GA_3	50	0.4484	0.4526	0.4441	0.4390	0.4428	**0.4454**
NAA	50	0.4610	0.4440	0.4521	0.4476	0.4492	**0.4508**
B_9	50	0.4571	0.4609	0.4525	0.4565	0.4609	**0.4576**
Mean		**0.4543**	**0.4475**	**0.4449**	**0.4482**	**0.4454**	**0.4481**
SLA (cm^2/g)							
Control	0	47.60	49.01	45.54	53.00	53.58	**49.75**
GA_3	50	51.44	51.29	55.04	54.45	54.37	**53.32**
NAA	50	50.97	49.04	49.22	56.62	56.19	**52.41**
B_9	50	49.83	49.76	50.32	49.11	47.75	**49.35**
Mean		**49.96**	**49.78**	**50.03**	**53.30**	**52.97**	**51.21**

Table (27): Changes in leaf area ratio (LAR-cm^2/g), leaf weight ratio (LWR) and specific leaf area (SLA-cm^2/g) at 90 days after sowing as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3, NAA or B_9 levels (season 2000/2001).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
		LAR (cm^2/g)					
Control	0	22.56	23.42	25.37	25.76	24.82	**24.39**
GA_3	50	25.79	28.77	22.85	26.98	23.36	**25.55**
	100	25.80	26.75	26.30	24.75	20.72	**24.86**
B_9	50	23.47	20.47	21.65	23.23	23.23	**22.41**
	100	26.06	21.84	18.64	26.04	22.69	**24.30**
Mean		**24.74**	**24.25**	**22.96**	**25.35**	**22.97**	**24.30**
		LWR					
Control	0	0.4469	0.4685	0.4738	0.4732	0.4484	**0.4622**
GA_3	50	0.4060	0.4724	0.4820	0.4613	0.4507	**0.4545**
	100	0.4372	0.4611	0.4366	0.4174	0.4292	**0.4363**
B_9	50	0.4658	0.4392	0.4914	0.4603	0.4346	**0.4583**
	100	0.4486	0.4418	0.4700	0.4451	0.4366	**0.4528**
Mean		**0.4409**	**0.4566**	**0.4708**	**0.4515**	**0.4399**	**0.4528**
		SLA (cm^2/g)					
Control	0	50.48	50.00	53.55	54.44	55.35	**52.76**
GA_3	50	63.51	60.89	47.41	58.48	51.82	**56.42**
	100	59.01	58.02	60.24	59.28	48.26	**56.96**
B_9	50	50.38	46.61	44.05	50.47	53.45	**48.99**
	100	58.09	59.44	39.67	58.50	51.96	**53.53**
Mean		**56.29**	**54.99**	**48.98**	**56.23**	**52.17**	**53.73**

Table (28): Changes in leaf area ratio (LAR-cm^2/g), leaf weight ratio (LWR) and specific leaf area (SLA-cm^2/g) at 120 days after sowing as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3, NAA or B_9 levels (season 2000/2001).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
LAR (cm^2/g)							
Control	0	31.25	24.58	25.19	28.38	25.48	**26.98**
GA_3	50	34.75	25.14	26.70	30.51	25.02	**28.42**
	100	35.45	26.55	26.05	33.18	23.67	**28.97**
B_9	50	34.22	28.22	29.31	33.80	27.66	**30.64**
	100	34.65	29.89	30.33	32.88	30.45	**31.64**
Mean		**34.06**	**26.88**	**27.52**	**31.75**	**26.45**	**29.33**
LWR							
Control	0	0.3613	0.3302	0.3275	0.3689	0.3735	**0.3523**
GA_3	50	0.3576	0.3419	0.3294	0.3628	0.3574	**0.3498**
	100	0.3593	0.3346	0.3368	0.3430	0.3519	**0.3451**
B_9	50	0.3603	0.3309	0.3317	0.3716	0.3786	**0.3546**
	100	0.3491	0.3376	0.3252	0.3881	0.3898	**0.3505**
Mean		**0.3575**	**0.3350**	**0.3301**	**0.3669**	**0.3702**	**0.3505**
SLA (cm^2/g)							
Control	0	86.49	74.44	76.93	76.93	68.22	**76.60**
GA_3	50	97.17	73.53	81.04	84.09	70.01	**81.17**
	100	98.67	79.35	77.33	96.72	67.27	**83.87**
B_9	50	94.97	85.29	88.36	90.97	73.05	**86.53**
	100	99.28	88.54	93.26	84.72	78.12	**88.78**
Mean		**95.32**	**80.23**	**83.38**	**86.69**	**71.33**	**83.39**

Table (29): Changes in leaf area ratio (LAR-cm^2/g), leaf weight ratio (LWR) and specific leaf area (SLA-cm^2/g) at 210 days after sowing as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3, NAA or B_9 levels (season 2000/2001).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
		LAR (cm^2/g)					
Control	0	20.46	20.47	18.82	22.39	21.14	**20.66**
GA_3	50	20.97	20.59	19.94	19.98	22.57	**20.81**
	100	20.09	21.24	20.09	21.62	21.88	**20.98**
B_9	50	21.88	21.75	18.38	19.16	20.66	**20.37**
	100	22.21	22.60	18.21	20.73	19.76	**20.70**
Mean		**21.12**	**21.33**	**19.09**	**20.78**	**21.20**	**20.70**
		LWR					
Control	0	0.4298	0.4164	0.4140	0.4282	0.4404	**0.4258**
GA_3	50	0.4332	0.4058	0.3833	0.4140	0.4182	**0.4109**
	100	0.4412	0.3907	0.3950	0.4194	0.4058	**0.4104**
B_9	50	0.4349	0.4310	0.4212	0.4259	0.4517	**0.4329**
	100	0.4425	0.4342	0.4145	0.4097	0.4464	**0.4200**
Mean		**0.4363**	**0.4156**	**0.4056**	**0.4194**	**0.4325**	**0.4200**
		SLA (cm^2/g)					
Control	0	47.60	49.16	45.53	52.29	48.00	**48.52**
GA_3	50	48.41	50.73	52.02	48.27	53.96	**50.68**
	100	45.53	54.36	50.86	51.55	53.96	**51.25**
B_9	50	50.32	50.46	43.63	44.97	45.74	**47.02**
	100	50.20	52.05	43.95	50.60	44.26	**49.37**
Mean		**48.41**	**51.35**	**47.20**	**49.54**	**49.18**	**49.37**

must be depended upon the efficiency ratio of dry matter formation by functional photosynthetic organ and its permission to translocate this matter into the resptor storage organ. At the rate of dry matter consumption is also expected either for building out new formed tissues or for release the phytochemical energy, require for different physiological processes.

2) As a general, and as mentioned before, functional photosynthetic organ of sugar beet, may be considered as highly efficient donor organ, as its retention from organic dry matter always less than those translocated into storage age organ, inspite of the continuos increase of shoot system growth in the terms of whole plant leaf area , fresh and dry weights of leaves.

3) The receptive dry matter material accumulation must be judged by many factors, endogenous and exogenous ones. It was found some variable amounts in the proportion of dry matter distribution in different plant organs between the plants grown under the tested conditions of the two seasons. Data of table (24) may indicate that the proportion of root only accumulation began in at the lowest levels, then increased during the second period then decline again at the last period of growth. The *vice versa* are true with regard to the proportion of dry matter accumulation in shoot system. The alternative change between root and shoot systems dry matter proportion could be discussed on the basis that this physiological phenomena is one of plant organ coordination.

There are some limiting variations in the distribution of dry matter in different plant organs as related to the foliar application of Cd or Pb with interaction effects of the examined growth regulator rates under the condition of this work , as there are irregular trends in this respect between different treatments.

Leaf area ratio (LAR), Leaf weight ratio (LWR) and specific leaf area (SLA) during different periods of growth:

As it was found before, there are coordination and correlation between sugar beet plant organs with relation to plant growth pattern. Also it was found that the most obvious effect of the various used treatments on plant growth, in terms of absolute actual parameters, was clearly observed on functionally photosynthetic area. Thus, it may be gained some information about whole plant leaf area with relation to dry matter accumulation either in whole plant or in leaves-self-government.

Leaf weight ratio (LWR) is considered as a part of dry matter distribution within plant organs, as it is the ratio of LDW/ whole plant D.W. This ratio is considered as a part of the dry matter distribution in leaves as related to those found in whole plant, but was found in the form of proportion ratio instead of percentage which be found in the previous case of root dry matter distribution. Thus LWR is considered as complementary data of the percentage distribution of dry matter in roots. These data of LWR were presented here in this part of growth analysis, for their complete relationships with the other ratios of LAR and SLA.

Specific leaf area (SLA) may be considered as leaf density or leaf expontion index or ratio. It must be mentioned here that there is complete correlation between the different proportional ratios as: LAR = LWR x SLA
In other words, the changes in LWR and SLA must be judged the efficiency growth index or ratio, i.e. LAR. Accordingly, these ratios must be changed under stress condition of heavy metals, which seemed to have negative effects in plant growth as discussed before in terms of absolute actual parameters. Also, any factor control plant growth, such as growth regulators, must be affected growth efficiency ratio through the changes in LWR and/or SLA. Accordingly, it may be beneficial to discuss the changes of LAR with relations to the

alternation of LWR and SLA. These data are presented in (Tables 25,26,27,28, and 29).

It may be detected the following conclusions from these data of growth analysis:

1) The physiological basis of the use LAR represents the efficiency of the plant as a producer of new dry material. The physiological basis of this latter conclusion is easily understood, for when photosynthesis has become active, the power of plant to synthesize new material -Uand hence in dry weight is clearly dependent upon the leaf – blade area **(Abd El-Hamid and El-Nabarawy,2001)**

2) It is worthy to mention that the higher synthesized dry matter formation accomplished with the constant or low leaf area formation, the lower LAR must be obtained. In other words, with continuos decrease in LAR, the continuos increase in growth efficiency index was gained, and the high efficiency of photosynthetic materials formation was obtained, i.e. there is an alternative or opposite correlation between LAR and the efficiency growth index (EGI). Of course, the changes in one or both of the LAR correlated ratios, LWR and /or SLA must be associated with the changes in LAR. therefore, the growth analysis of whole plant seemed to be greatly related to the leaf dimensions, i.e. the area and /or the photosynthetic efficiency rate. in the other words which are the organs most directly concerned in the synthesis of new motenriols, this constitute a dimensioning fraction of the total plant dry weight, i.e. the efficiency ratio of dry weight production (Abd El Hamied and El-Nabarawy 2001).

3) According to the above mentioned basis, LAR seemed to relatively high when the plants reaches into 120days after sowing (season 1&2), the stage of the beginning root development, but this ratio declined greatly at harvesting stage 210 days after sowing, the full mature stage and the end of root development stage, as its dry weight reached into

the maximum, otherwise the full synthesized storage materials in roots were complemented. LAR was also showed lower values when the plants reached into 90 days after sowing (season 2). This means that the growth efficiency index (ratio or LAR), must be changed according to the stage of the plant growth. In other words, during the later period of growth, plant senescence stage, LAR reached onto the lowest level. The lower the ratio of LAR, the lower the ratio of SLA were gained, which associated with the higher of LWR ratio, Accordingly it may be concluded that SLA and LWR interpreted the growth efficiency index or LAR. It was suggested that leaf density or SLA was the more effected values for determing growth efficiency index anther than LWR, as deep change in SLA was gained in relation to those of LWR. In the words, the low in the ratio of SLA, i.e. the leaf area cm^2/ one gram of leaves dry matter, the high relatively efficiency of photosynthetic rate was gained and the *vice versa* is true.

4) With regard to the effects of the toxic heavy metals on different tested ratios, it may be concluded that limiting changes were obtained As LAR increased slightly during early period of growth (90 days of season 2) associated with mostly higher LWR and SLA. However, a deep reduction in LAR was gained after 120 days under heavy metal treated plant without using growth regulators, associated with the reduction in SLA and LWR (in the case of Cd treatments). The same conclusion may be detected during the later period of growth. The effects of Cd of the tested different ratio seemed to be more than Pb in this respect and this may be lead to the assumption that Cd is more toxic than Pb. Also, there were same differences in these ratios during both growing seasons. Accordingly, it could be assumed that their are two alternative mechanisms of phytotoxifecation action of whole plant growth efficiency index which changed according to the growth period and may be governed for same extent by environmental factors.

5) With regards to the effects of the tested growth regulators, without the use of heavy metals, it may be concluded that such substances seemed to be have a regulatory effects on the tested ratios, as they mostly increased the LAR, (except NAA, which seemed to be have limiting effects in this respects), and SLA associated with no clear trends with LWR. The highly effect in this respect seemed to be gained by GA_3 in this respect.

6) With regard to the combined effects of Cd or Pb with growth regulators, it could be stated that growth regulators modified for some extent the phototoxifecation of the used heavy metals. However, it may be concluded that no clear trends could be obtained under the different rats of the tested Cd or Pb X various levels of GA_3, NAA or B_9, during different periods of growth in this respect. In other words, the complicated mechanism of action the used growth regulators must be varied according to many factors especially under the variable levels of the stress of heavy metals.

7- Our results was in agreement with those obtained by **El-Nabarawy (2002)** concluded that Cd seemed to be affected spinach plant growth through its depressive effects on specific leaf area (SLA) as this relation between leaf area and its dry weight ratio decreased with the presence of Cd in root medium and always lower than the control plants, while leaf weight ratio (LWR) is more or less constant under Cd treated or untreated control plants during different periods of growth, accordingly, the decreased ratio in leaf area ratio (LAR) must be related to the decrease in specific leaf area and not related to (LWR).

Also **Sorial and Abd-El Fattah (2001)** reported that the highest levels of Pb decreased significantly relative growth rate (RGR), leaf area ratio (LAR) and net assimilation rate (NAR) comparing with untreated plants. **Greger *et al.***

(1991) and Landberg and Greger (1994) proved that Cd inhibited (RGR) in sugar beet plants. **Abo – Kassem *et al.*(1995)** reported that toxic effect of Cd on RGR of wheat plants is due to (NAR) retardation rather than to leaf area ratio (LAR) inhibition the main factor limiting plant growth was NAR inhibition due to decrease in photosynthesis, who reported that one of the reasons for the reduced photosynthetic rate was the lower plastid pigment content which accelerates respiration.

Plant organ water relations:

Plant organ water relations were determined in roots in terms of root dry weight / root fresh weight x 100,i.e. as a percentage, but in leaves this water relation was estimated as mg H_2O/cm^2 of leaf. These data are tabulated in Table ,30,31, 32 and 33. It may be detected the following conclusions from these available data:

1-As a general, mostly very limiting increase in the percentage of root dry weight / its fresh weight during different periods of growth, reaching the maximum at harvesting stage 210 days. This indirectly means that the moisture in roots decreased relatively with plant advancing age.

2-Both heavy metals affected the ratio of root weight RDW/RFW, i.e. affected the ratio of water balan in root system. Roots of Cd or Pb treated plants in the absence of growth regulator treatments seemed to be have relatively more succulence degree, as the RDW/RFW decreased as related to the control, during most periods of plant growth.

3-In the absence of heavy metal treatments, growth regulators seemed to be have limiting effects on the succunce degree of root tissues. However, GA_3 and B_9 mostly regulate slightly the water balance in roots, as both treated plants with them, showed relatively limiting increase in RDW/RFW %,i.e. decreased slightly the succulence grade of roots.

4-The tested growth regulators effects on root succulence grade were extended to regulate the toxic effects of Cd or Pb on water balance in roots.

Table (30) : Changes in water status in root in termes of root dry weight /root fresh weight percentage as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3, NAA or B_9 levels (season 1999/2000).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	20	50	20	50	
		120 days after sowing					
Control	0	19.2	18.8	18.8	18.9	18.1	**18.8**
GA_3	50	20.0	20.1	19.5	19.6	19.1	**19.7**
NAA	50	19.5	20.0	18.1	17.5	17.2	**18.5**
B_9	50	20.3	20.4	19.9	19.2	18.8	**19.7**
Mean		**19.7**	**19.8**	**19.1**	**18.8**	**18.3**	**19.2**
		210 days after sowing					
Control	0	21.6	21.4	20.7	21.0	21.4	**21.2**
GA_3	50	23.6	21.3	20.8	22.4	21.5	**21.9**
NAA	50	22.2	21.1	19.1	23.0	21.8	**21.4**
B_9	50	23.2	21.4	21.0	23.1	22.9	**22.3**
Mean		**22.7**	**21.3**	**20.4**	**22.4**	**21.9**	**21.7**

Table (31): Changes in water status in root in terms of root dry weight/root fresh weight percentage as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 or B_9 levels (season 2000/2001).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	20.8	18.5	18.3	18.0	18.0	**18.7**
GA_3	50	19.9	19.1	18.5	19.4	19.0	**19.2**
	100	20.4	20.0	20.0	19.8	19.4	**19.9**
B_9	50	19.9	20.0	18.9	19.8	19.2	**19.6**
	100	20.9	20.6	19.6	19.9	19.5	**20.1**
Mean		**20.4**	**19.6**	**19.1**	**19.4**	**19.0**	**19.5**
120 days after sowing							
Control	0	19.9	20.0	19.7	18.6	18.9	**19.4**
GA_3	50	20.5	20.0	20.2	19.2	19.0	**19.8**
	100	21.3	21.3	21.0	20.6	20.0	**20.8**
B_9	50	20.5	20.9	19.8	19.8	20.0	**20.2**
	100	21.7	21.2	21.0	20.2	20.0	**20.8**
Mean		**20.9**	**20.7**	**20.3**	**19.7**	**19.6**	**20.2**
210 days after sowing							
Control	0	22.5	21.6	20.5	21.6	20.0	**21.2**
GA_3	50	23.3	22.7	22.0	23.5	21.6	**22.6**
	100	24.2	24.0	22.0	24.0	23.1	**23.5**
B_9	50	23.5	22.6	22.3	22.9	20.7	**22.4**
	100	24.6	23.0	22.5	23.9	22.9	**23.4**
Mean		**23.6**	**22.8**	**21.9**	**23.2**	**21.7**	**22.6**

Table (32): Changes in leaf succulence grade (index)(mg water/cm^2) of sugar beet plant during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3, NAA or B_9 levels (season 1999/2000).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	20	50	20	50	
		120 days after sowing					
Control	0	71	82	97	71	78	**79.8**
GA_3	50	56	61	65	57	61	**60.0**
NAA	50	75	80	93	79	82	**81.8**
B_9	50	63	79	84	60	61	**69.4**
Mean		**66.3**	**75.5**	**84.8**	**66.8**	**70.5**	**72.8**
		210 days after sowing					
Control	0	87	95	105	83	88	**91.6**
GA_3	50	73	81	80	77	79	**78.0**
NAA	50	78	91	96	74	80	**83.8**
B_9	50	79	94	87	83	85	**85.6**
Mean		**79.3**	**90.3**	**92.0**	**79.3**	**83.0**	**84.8**

Table (33): Changes in leaf succulence grade (index)(mgwater/cm^2) of sugar beet plant, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 or B_9 levels (season 2000/2001).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	154	156	147	149	204	**162**
GA_3	50	126	128	147	131	163	**139**
	100	112	129	115	120	156	**126**
B_9	50	148	161	156	151	149	**153**
	100	127	149	169	128	149	**144**
Mean		**133**	**145**	**147**	**136**	**164**	**145**
120 days after sowing							
Control	0	70	90	91	84	100	**87**
GA_3	50	60	85	84	73	94	**79**
	100	56	76	82	64	93	**74**
B_9	50	63	76	76	69	87	**74**
	100	59	70	72	67	68	**67**
Mean		**62**	**79**	**81**	**71**	**88**	**76**
210 days after sowing							
Control	0	86	91	98	83	94	**90**
GA_3	50	79	85	89	87	86	**85**
	100	77	77	81	77	84	**79**
B_9	50	76	80	98	90	89	**87**
	100	69	75	95	79	85	**81**
Mean		**77**	**82**	**92**	**83**	**88**	**84**

The most obvious effects in this respect may be shown under GA_3or B_9 treated plants.

5-We assumed that the limiting in root water balance by Cd or Pb, is a part of both heavy metal phytotoxification actions, which may be partially regulated by using specific growth regulators, i.e. partial detoxification actions.

6-With regard to the direct estimation of leaf succulence degree as mg H_2O /cm^2 of leaf area, it was found the following conclusions:

A) Both of Cd or Pb treated leaves contained higher amounts of water than the 0.0 treated leaves, and the used growth regulators seemed to be check this troublness in leaves water troublness balance by the phytotoxification of Cd or Pb.

B)The higher moisture contents exhibited in Cd or Pb treated leaves may be related to the desfuntional closing and opening mechanism under Cd or Pb stress (**Greger and Johansson, 1992**). It must be mentioned here that Cd causes closure of stomata (**Bazzaz *et al* ., 1974; Schlegel *et al.,* 1987; Barcelo *et al.*, 1988; Poschenrieder *et al.,* 1989; Greger and Johansson, 1992)**, and Pb my be have the same effects.

C)This adverse effect on water statues in leaves could be checked by the used growth regulators, as the succulence degree in leaves was controlled by the use of specific growth regulator, with mostly pronounced effect by using GA_3. The only loss of water from leaves seemed to from cuticle and epidermal cell wall / cuticolor membrane system, but this system is also controlled by the use of heavy metals as foliar spray (see **Greger *et al.,* 1993** in their complete study in this respect on sugar beet plant).

7-The different aforementioned results, concerned the water balance in either of roots or leaves of sugar beet plant under the stress of heavy metals foliar spray, may be discussed on the following conclusion:

a)The trouble in sugar beet organs water relations, as related to foliar application of Cd or Pb, may be discussed on the basis that both of heavy metal depressed plant growth especially leaf area and SLA, so that the transparent epicutical area decrease, with relation to the closed stomata as mentioned before.

b)**Greger and Johansson 1992** concluded that Cd affected the water absorption, water transpiration and water translocation within plant, as Cd has a harmful effects on plasma membrane, which affected the permeability of water and solutes. **Schickler and Caspi (1999)** related the disbalance of water within plant organ tissues to the membrane damage and the metabolism troublness as resulted by Cd or Pb .

c)**Sorial *et al.*, (2001), Aidid and Okamato (1992**) reported that cell membranes are considered the primary sites of heavy metal injury. They added also that these metals induced changes in membrane properties leading to membrane disfunction carriers and ion chainels as well as the permeability of cell membranes to water. Many studies showed that even low concentration of Pb could cause severe ultrastructural damage by interference with the structural integrity of the organelles such as chloroplasts and mitochondria **Buwalada (1992)**, in addition to inhibiting metabolic processes by direct production of enzyme activities **Quariti, *et al.*, (1997),**

d)Growth regulators affected the plant water relations under stress conditions, by their control on water absorption, translocation or transpiration **Abd El-Hamid *et al.*,(1992, a and b) .**

Photosynthetic pigments concentration:

Photosynthetic pigments concentration i.e Chlorophyll a,b and carotenoids changes as affected by the tested combined factors are tabulated in Tables, (34,35,36 and 37). From these data it may be concluded the following conclusion:

1- As a general, irrespective to any treatments, chlorophyll's increase during different periods of growth till they reached into the maximum after 120 days then decreased slightly during maturation (storage stage) till reached into the minimum at the later period of growth, plant senescence stage .

2- chlorophyll concentration decreased as Cd and Pb levels were increased, particularly at high concentration . It was clear that the data of the second season followed the same trend of the first one . The same result was observed by **Sorial and Abd El-Fattah (2001) and Soudi (1998).**

3- Foliar spray of growth regulators GA_3 , NAA and B_9 (at 50mg l^{-1}) in the first season or GA_3 and B_9 (at 50-100mg l^{-1}) in the second one increased photosynthetic pigments concentration in this connection **. Miseha *et al.* (1992)** reported that GA_3 regulated and controlled the processes of leaves development during different periods of growth .

4- With regard to the combined effects of different Cd or Pb rates with variable G NAA and B_9 levels decreased the harmful effect of the used heavy metals photosynthetic pigments concentration. Plastid pigments have been shown as of the main sites of the toxic Cd action . It was established that Cd decrea chlorophyll content in many plant species e.g., tomatoes **(Baszynski *et al.*, 19** wheat and cucumber **(Malik *et al.*,1992**) maize **(El-Enany, 1995)** and be **(Krupa and Baszynski, 1995).**

Table (34): Changes in Chlorophyll a, b and carotenoids (mg/g F.w) as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3, NAA and B_9 levels (season 1999/2000).

Heavy Metals (mg/l) (HM) / Growth Regulator (mg/l)(GR)		Control	Cd		Pb		Mean
		0	20	50	20	50	
120 days after sowing							
Chlorophyll (a)							
Control	0	1.552	1.501	1.398	1.503	1.393	**1.469**
GA_3	50	1.634	1.693	1.601	1.600	1.620	**1.630**
NAA	50	1.582	1.542	1.445	1.581	1.400	**1.510**
B_9	50	1.520	1.499	1.365	1.500	1.489	**1.475**
Mean		**1.572**	**1.559**	**1.452**	**1.546**	**1.476**	**1.521**
Chlorophyll (b)							
Control	0	0.661	0.635	0.602	0.646	0.621	**0.633**
GA_3	50	0.670	0.654	0.623	0.652	0.620	**0.644**
NAA	50	0.662	0.638	0.608	0.631	0.606	**0.629**
B_9	50	0.690	0.678	0.638	0.680	0.645	**0.666**
Mean		**0.671**	**0.651**	**0.618**	**0.652**	**0.623**	**0.643**
Carotenoids							
Control	0	0.418	0.393	0.382	0.404	0.385	**0.396**
GA_3	50	0.449	0.431	0.401	0.431	0.401	**0.423**
NAA	50	0.416	0.388	0.355	0.383	0.367	**0.382**
B_9	50	0.440	0.421	0.385	0.420	0.400	**0.413**
Mean		**0.431**	**0.408**	**0.381**	**0.410**	**0.388**	**0.404**
210 days after sowing							
Chlorophyll (a)							
Control	0	1.184	1.135	1.014	1.104	1.015	**1.090**
GA_3	50	1.231	1.156	1.086	1.159	1.113	**1.149**
NAA	50	1.189	1.160	1.044	1.152	1.011	**1.111**
B_9	50	1.180	1.171	1.015	1.174	1.010	**1.110**
Mean		**1.196**	**1.156**	**1.040**	**1.147**	**1.037**	**1.115**
Chlorophyll (b)							
Control	0	0.367	0.358	0.337	0.352	0.338	**0.350**
GA_3	50	0.391	0.351	0.344	0.350	0.344	**0.356**
NAA	50	0.388	0.341	0.338	0.340	0.329	**0.347**
B_9	50	0.400	0.363	0.345	0.400	0.340	**0.370**
Mean		**0.387**	**0.353**	**0.341**	**0.361**	**0.338**	**0.356**
Carotenoids							
Control	0	0.229	0.212	0.196	0.218	0.206	**0.212**
GA_3	50	0.387	0.268	0.255	0.260	0.249	**0.284**
NAA	50	0.221	0.210	0.186	0.219	0.208	**0.209**
B_9	50	0.280	0.268	0.245	0.286	0.241	**0.264**
Mean		**0.279**	**0.240**	**0.221**	**0.246**	**0.226**	**0.242**

Table (35): Changes in Chlorophyll a, b and carotenoids(mg/g F.w) after 90 days from sowing as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 or B_9 levels (season 2000/2001).

Heavy Metal (HM) (mg/l) / Growth Regulator (G.R)(mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
Chlorophyll (a)							
Control	0	1.100	1.087	0.911	0.883	0.835	**0.963**
GA_3	50	1.410	1.393	1.378	1.205	1.020	**1.281**
	100	1.509	1.431	1.260	1.451	1.485	**1.427**
B_9	50	1.303	1.242	1.020	0.998	0.903	**1.093**
	100	1.485	1.334	1.139	1.106	1.000	**1.213**
Mean		**1.361**	**1.297**	**1.142**	**1.129**	**1.049**	**1.196**
Chlorophyll (b)							
Control	0	0.690	0.575	0.535	0.627	0.626	**0.611**
GA_3	50	0.654	0.616	0.535	0.698	0.729	**0.646**
	100	0.709	0.607	0.670	0.565	0.644	**0.639**
B_9	50	0.719	0.640	0.675	0.577	0.632	**0.649**
	100	0.729	0.705	0.638	0.633	0.666	**0.674**
Mean		**0.700**	**0.629**	**0.611**	**0.620**	**0.659**	**0.644**
Carotenoids							
Control	0	0.420	0.395	0.365	0.414	0.400	**0.399**
GA_3	50	0.464	0.430	0.376	0.391	0.364	**0.405**
	100	0.468	0.457	0.390	0.400	0.382	**0.419**
B_9	50	0.460	0.392	0.366	0.420	0.425	**0.413**
	100	0.486	0.368	0.347	0.461	0.468	**0.426**
Mean		**0.460**	**0.408**	**0.369**	**0.417**	**0.408**	**0.412**

Table (36): Changes in Chlorophyll a, b and carotenoids(mg/g F.w) after 120 days from sowing as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 or B_9 levels (season 2000/2001).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
		Chlorophyll (a)					
Control	0	1.493	1.393	1.227	1.399	1.350	**0.399**
GA_3	50	1.551	1.409	1.341	1.467	1.253	**0.405**
	100	1.648	1.548	1.600	1.689	1.642	**0.419**
B_9	50	1.580	1.423	1.331	1.519	1.461	**0.413**
	100	1.589	1.451	1.354	1.660	1.465	**0.426**
Mean		**0.460**	**0.408**	**0.369**	**0.417**	**0.408**	**0.412**
		Chlorophyll (b)					
Control	0	0.744	0.686	0.585	0.758	0.767	**0.708**
GA_3	50	0.761	0.701	0.687	0.802	0.773	**0.745**
	100	0.891	0.796	0.738	0.818	0.780	**0.805**
B_9	50	0.774	0.706	0.663	0.764	0.729	**0.727**
	100	0.787	0.746	0.688	0.788	0.740	**0.750**
Mean		**0.791**	**0.727**	**0.672**	**0.786**	**0.758**	**0.747**
		Carotenoids					
Control	0	0.499	0.476	0.442	0.486	0.479	**0.476**
GA_3	50	0.496	0.488	0.451	0.491	0.477	**0.481**
	100	0.508	0.502	0.465	0.503	0.496	**0.495**
B_9	50	0.497	0.470	0.441	0.500	0.483	**0.478**
	100	0.503	0.482	0.472	0.513	0.491	**0.492**
Mean		**0.501**	**0.484**	**0.454**	**0.499**	**0.485**	**0.484**

Table (37): Changes in Chlorophyll a, b and carotenoids(mg/g F.w) after 210 days from sowing as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 or B_9 levels (season 2000/2001).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
		Chlorophyll (a)					
Control	0	0.970	0.825	0.760	0.786	0.621	**0.792**
GA_3	50	1.187	0.899	0.699	1.201	1.221	**1.041**
	100	1.202	1.178	0.800	1.315	1.310	**1.161**
B_9	50	0.984	0.876	0.855	1.213	1.111	**1.008**
	100	0.995	0.899	0.790	1.282	1.245	**1.042**
Mean		**1.068**	**0.935**	**0.781**	**1.159**	**1.102**	**1.009**
		Chlorophyll (b)					
Control	0	0.525	0.486	0.460	0.492	0.454	**0.483**
GA_3	50	0.545	0.499	0.487	0.521	0.508	**0.512**
	100	0.583	0.530	0.509	0.561	0.553	**0.547**
B_9	50	0.519	0.500	0.484	0.525	0.510	**0.508**
	100	0.530	0.518	0.477	0.538	0.524	**0.517**
Mean		**0.540**	**0.507**	**0.483**	**0.527**	**0.510**	**0.514**
		Carotenoids					
Control	0	0.385	0.352	0.330	0.371	0.360	**0.360**
GA_3	50	0.400	0.384	0.355	0.398	0.379	**0.383**
	100	0.421	0.392	0.372	0.410	0.386	**0.396**
B_9	50	0.421	0.398	0.388	0.370	0.361	**0.388**
	100	0.433	0.411	0.392	0.384	0.380	**0.400**
Mean		**0.412**	**0.387**	**0.367**	**0.387**	**0.373**	**0.385**

The reduced chlorophyll concentration in Cd-treated plant is due to inhibitions of its biosynthesis (**Stobart *et al.*, 1985**) and / or activation of its enzymatre degradation (**Somashekaraiah, 1992). Lang *et al.*,(1995**) related the decreased in chlorophyll content to the Cd^{+2} induced iron deficiency in plants and **Prasad (1995**) related the closure of stomata by Cd^{2+} .

The harmful effected of Pb on photosynthetic pigments due to the reduction in chlorophyll content maybe attributed to the inhibition of chlorophyll biosynthesis in treated plants as suggested by some published reports which indicated that Pb accumulate in chloroplast disorganizing their ultrastucture and decreasing the biosynthesis of chloroplasts (**Lukaszek and Poskuta, 1998 and Zaman and Zereen 1998**).

5- A considerable observation was that the promising effect of GA_3 or B_9 in alleviating the deleterious effect of Cd and Pb pollution was much more pronounced at relatively higher concentration of the heavy metal. Data also showed that Cd was more suppress due than Pb in sugar beet plants in two seasons. These results are in conformity with those of **Aidid and Okamoto (1992**) **Sorial and Abdel-Fattah (2001) Krupa *et al.*,(1993**) reported that Cd concentration in the nutrient medium decrease in chloroplast pigment level i.e. chlorophyll's and carotenoids.

Status of sugars:

The effect of Cd or Pb at different concentrations, some growth regulators, GA_3, NAA and B_9 at different rates and their interaction on sugars (mg/g D.W) in beet roots at (90,120 and 210 days from sowing) are summarized in Tables (38,39,40 and 41). It maybe concluded the following:

1- As general, reducing, non-reducing and total sugars in the roots mostly increased gradually till reached its maximum at harvesting stage (210 days

Table (38): Changes in sugars (mg/g D.W) of sugar beet root, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3, NAA and B_9 levels (season 1999/2000).

Heavy Metals (mg/l) (HM) / Growth Regulator (mg/l) (GR)		Control	Cd		Pb		Mean
		0	20	50	20	50	
Reducing sugars							
120 days after sowing							
Control	0	25.6	24.4	21.8	23.9	21.5	**23.4**
GA_3	50	28.5	26.2	25.1	25.8	24.7	**26.1**
NAA	50	26.2	25.3	23.6	24.8	22.3	**24.4**
B_9	50	27.7	25.9	24.3	24.8	22.2	**25.0**
Mean		**27.0**	**25.5**	**23.7**	**24.8**	**22.7**	**24.7**
210 days after sowing							
Control	0	32.9	30.3	27.2	31.0	28.7	**30.0**
GA_3	50	36.2	35.1	31.2	35.5	32.9	**34.2**
NAA	50	34.7	33.7	29.8	31.4	30.4	**32.0**
B_9	50	33.5	31.2	28.0	31.6	29.2	**30.7**
Mean		**34.3**	**32.6**	**29.1**	**32.4**	**30.3**	**31.7**
Non reducing sugars							
120 days after sowing							
Control	0	433.8	429.2	420.8	429.5	414.3	**425.5**
GA_3	50	456.3	423.6	446.3	439.9	435.4	**440.3**
NAA	50	415.4	410.5	402.5	408.3	401.7	**407.7**
B_9	50	428.9	419.8	413.8	412.2	413.9	**417.7**
Mean		**433.6**	**420.8**	**420.9**	**422.5**	**416.3**	**422.8**
210 days after sowing							
Control	0	656.5	639.8	628.9	642.4	635.5	**640.6**
GA_3	50	672.2	644.9	652.0	695.6	683.2	**669.6**
NAA	50	660.0	655.3	634.9	652.8	660.4	**652.7**
B_9	50	660.0	645.5	635.8	634.1	645.8	**644.2**
Mean		**662.2**	**646.4**	**637.9**	**656.2**	**656.2**	**651.8**
							Total sugars
120 days after sowing							
Control	0	459.4	453.6	442.6	453.4	435.8	**449.0**
GA_3	50	484.8	479.8	471.4	465.7	460.1	**472.4**
NAA	50	441.6	435.8	426.1	433.1	424.0	**432.1**
B_9	50	456.6	445.7	438.1	437.0	436.1	**442.7**
Mean		**460.6**	**453.7**	**444.6**	**447.3**	**439.0**	**449.0**
210 days after sowing							
Control	0	689.4	670.1	656.7	673.4	664.2	**670.8**
GA_3	50	708.4	680.0	683.2	731.1	716.1	**703.8**
NAA	50	694.7	689.0	664.7	684.2	690.8	**684.7**
B_9	50	693.5	676.7	663.8	665.7	675.0	**674.9**
Mean		**696.5**	**679.0**	**667.1**	**688.6**	**686.5**	**683.5**

Table (39): Changes in reducing sugars (mg/g D.W) of sugar beet root, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 and B_9 levels (season 2000/2001).

Heavy Metals (HM) (mg/l) / Growth Regulator (GR) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
		90 days after sowing					
Control	0	22.5	18.3	17.2	19.0	18.3	**19.1**
GA_3	50	24.2	18.9	17.1	19.3	18.6	**19.6**
	100	25.8	19.2	18.0	20.1	19.7	**20.6**
B_9	50	25.4	19.2	17.6	20.1	18.0	**20.1**
	100	26.1	19.3	18.7	20.8	18.8	**20.7**
Mean		**24.8**	**19.0**	**17.7**	**19.9**	**18.7**	**20.01**
		120 days after sowing					
Control	0	26.0	23.8	19.6	24.1	19.0	**22.5**
GA_3	50	27.1	25.2	19.8	25.8	19.3	**23.4**
	100	27.5	27.1	20.2	27.0	20.2	**24.4**
B_9	50	26.5	25.1	20.0	25.3	19.8	**23.3**
	100	26.8	26.3	20.0	26.9	20.0	**24.0**
Mean		**26.8**	**25.5**	**19.9**	**25.8**	**19.7**	**23.5**
		210 days after sowing					
Control	0	30.1	24.0	21.0	25.0	25.0	**25.0**
GA_3	50	32.7	27.3	25.3	27.3	25.9	**27.7**
	100	33.9	27.8	26.1	27.0	25.3	**28.0**
B_9	50	35.1	28.5	25.3	27.9	26.7	**28.7**
	100	36.7	28.0	26.1	28.1	26.9	**29.2**
Mean		**33.7**	**27.1**	**24.8**	**27.1**	**26.0**	**27.7**

Table (40): Changes in non-reducing sugars (mg/g D.W) of sugar beet root, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 and B_9 levels (season 2000/2001).

Heavy metals (HM) (mg/l) / Growth Regulator (GR) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	292.7	278.2	260.4	269.5	260.3	**272.2**
GA_3	50	297.9	289.8	252.2	261.1	271.8	**274.6**
	100	308.0	292.9	277.8	277.7	273.0	**285.9**
B_9	50	298.9	272.9	230.7	296.7	300.5	**279.9**
	100	313.0	290.0	196.1	301.2	302.2	**280.5**
Mean		**302.1**	**284.8**	**243.4**	**281.2**	**281.6**	**278.6**
120 days after sowing							
Control	0	342.5	339.7	324.8	340.0	327.3	**334.9**
GA_3	50	363.8	358.1	351.9	363.7	359.4	**359.4**
	100	375.2	364.8	347.0	368.9	349.2	**361.0**
B_9	50	359.6	344.8	337.4	352.9	347.1	**348.4**
	100	364.9	358.7	340.3	359.1	349.8	**354.6**
Mean		**361.2**	**353.2**	**340.3**	**356.9**	**346.6**	**351.6**
210 days after sowing							
Control	0	684.9	664.0	647.0	662.7	648.1	**661.3**
GA_3	50	706.3	672.7	665.7	682.2	679.1	**681.2**
	100	709.1	694.2	690.9	701.9	700.0	**699.2**
B_9	50	699.9	671.5	664.7	692.7	694.1	**684.6**
	100	705.3	703.0	691.9	701.0	692.2	**698.7**
Mean		**701.1**	**681.1**	**672.0**	**688.1**	**682.7**	**685.0**

Table (41): Changes in total sugars (mg/g D.W) of sugar beet root, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 and B_9 levels (season 2000/2001).

Growth Regulator (GR) (mg/l) \ Heavy Metals (HM) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	315.2	296.5	277.6	288.5	278.6	**291.3**
GA_3	50	322.1	308.7	269.3	380.4	290.4	**314.2**
	100	333.8	312.1	295.8	297.8	292.7	**306.4**
B_9	50	324.3	292.1	248.3	316.8	318.5	**300.0**
	100	339.1	309.3	214.8	322.0	320.9	**301.2**
Mean		**326.9**	**303.7**	**261.2**	**321.1**	**300.2**	**302.6**
120 days after sowing							
Control	0	368.5	363.5	344.4	364.1	346.3	**357.4**
GA_3	50	390.9	383.3	371.7	389.5	378.7	**382.8**
	100	402.7	391.9	367.2	395.9	369.4	**385.4**
B_9	50	386.1	369.9	357.4	378.2	366.9	**371.7**
	100	391.7	385.0	360.3	386.0	369.8	**378.6**
Mean		**388.0**	**378.7**	**360.2**	**382.7**	**366.2**	**375.2**
210 days after sowing							
Control	0	715.0	788.0	668.0	687.7	673.1	**706.4**
GA_3	50	739.0	700.0	591.0	709.5	705.0	**688.9**
	100	743.0	722.0	717.0	728.9	725.3	**727.2**
B_9	50	735.0	700.0	690.0	720.6	720.8	**713.3**
	100	742.0	731.0	718.0	729.1	719.1	**727.8**
Mean		**734.8**	**728.2**	**676.8**	**715.2**	**708.7**	**712.7**

from sowing). Also, reducing sugars was lower than non-reducing sugars and the proportion of non-reducing sugars increased gradually until the harvesting stage, while, reducing sugars decreased . These means that reducing sugars converted into non-reducing one (as the sugars storage in roots in the form sucrose).

2- Foliar sprays with Cd or Pb at different levels gave the negative effects on reducing, non-reducing and total sugars. In this concern, Cd pollutant was more effective in sugars than Pb effect.

The negative effect of Cd and Pb on sugars concentration might be attributed to its deleterious effect on the rate of sugar biosynthesis and flow of photoassimilates **(Poskuta *et al.*, 1987).** Also, **Greger *et al.*, (1991)** found that sugar beet plants grown with Cd^{2+} showed avery low photosynthetic activity. The inhibition of photosynthetic activity caused by Cd was not affected by the way in which nutrients and Cd^{2+} were added. Moreover, the inhibitory effect of Cd and Pb on the photosynthetic enzyme ribulose biphosphate carboxylase (Ru BPC), reported by **Salisbury and Ross (1992)**.

3- With regard to the effect of the tested growth regulators on sugars, it may concluded that GA_3, NAA or B_9 increased reducing, non-reducing and total sugar through different sampling dates in two seasons.

4- Interaction between heavy metals Cd or Pb with some growth regulators GA_3, NAA and B_9 increased the partial detoxification action of Cd or Pb. The higher rate of GA_3 or B_9 increased the plant tolerance to heavy metal stress, NAA seemed to have the least effect in this connection **Soudi (1998)**, **Sorial and Abdel-Fattah (2001)** mentioned that Cd and Pb of all concentrations gave the negative effect on total sugars and total carbohydrate .

Specific nutrient concentration:

The concentration of N, P, K and Na in roots and shoots were presented in Tables (42, 43 To 57) as nutrient unit per plant organ as well as whole plant as affected by the tested combined factors. It may be observed the following conclusion:

1- Irrespective to Cd or Pb stress effect on nutrients accumulation in sugar beet plant organs, leaves possessed relatively higher accumulation proportion amounts of different nutrients as related to roots.
2- Also, irrespective to heavy metals stress effect the actual accumulated amounts of all tested elements increased with plant got older, with higher accumulation amount, during the last period of growth.
3- It was found from the data that the low Cd and Pb level (20mg l^{-1}) seemed to be with small alteration effects on the total actual contents of the most different tested elements per plant organs as compared with those corresponding ones under control plant treatment or those subjected under middle (50mg l^{-1}) or high Cd or Pb levels (100mg l^{-1}) (with some exceptions).
4- Cd or Pb levels at 50 or 100mg l^{-1} may be have an obvious effects on the uptake, translocations and accumulations of the tested elements in this respect .
5- As a general, the total actual amount (g/plant) of N, P, K and Na were decreased in both sugar beet plant organs in two seasons in the presence of Cd or Pb at all levels under studied.
6- the total actual amounts of the nutrients are the expression of elements concentration and the degree of plants organs growth .

Table (42): Changes in nitrogen (g/plant) of sugar beet plant, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3, NAA and B_9 levels (season 1999/2000).

Heavy Metals (HM) (mg/l) / Growth Regulator (GR) (mg/l)		Control	Cd		Pb		Mean
		0	20	50	20	50	
120 days after sowing (in root).							
Control	0	2.89	2.43	2.38	2.82	2.41	**2.59**
GA_3	50	3.97	3.48	3.19	3.32	2.94	**3.38**
NAA	50	3.11	2.83	1.43	2.63	1.86	**2.37**
B_9	50	3.51	3.13	2.07	3.16	2.92	**2.96**
Mean		**3.37**	**2.97**	**2.27**	**2.98**	**2.53**	**2.82**
210 days after sowing (in root).							
Control	0	3.29	2.94	2.39	2.69	1.97	**2.66**
GA_3	50	4.23	3.52	3.18	3.82	2.92	**3.53**
NAA	50	2.92	2.91	2.07	2.79	1.94	**2.53**
B_9	50	3.12	2.32	1.67	3.32	2.52	**2.59**
Mean		**3.39**	**2.92**	**2.33**	**3.16**	**2.34**	**2.83**
120 days after sowing (in leaves).							
Control	0	2.43	2.19	1.97	2.29	1.98	**2.17**
GA_3	50	2.93	2.68	2.47	2.89	2.68	**2.73**
NAA	50	2.62	2.51	2.03	2.46	2.15	**2.35**
B_9	50	2.79	2.42	2.27	2.58	2.25	**2.46**
Mean		**2.69**	**2.45**	**2.19**	**2.56**	**2.27**	**2.43**
210 days after sowing (in leaves).							
Control	0	4.55	3.52	2.83	3.88	3.30	**3.62**
GA_3	50	6.24	5.29	4.38	5.18	5.04	**5.23**
NAA	50	5.15	4.14	3.93	4.22	3.63	**4.21**
B_9	50	5.87	5.14	4.24	5.38	4.73	**5.07**
Mean		**5.45**	**4.52**	**3.85**	**4.67**	**4.18**	**4.53**
120 days after sowing (in whole plant).							
Control	0	5.32	4.62	4.35	5.11	4.39	**4.76**
GA_3	50	6.90	6.16	5.66	6.21	5.62	**6.11**
NAA	50	5.73	5.34	3.46	5.09	4.01	**4.73**
B_9	50	6.30	5.55	4.34	5.74	5.17	**5.42**
Mean		**6.06**	**5.42**	**4.45**	**5.54**	**4.80**	**5.25**
210 days after sowing (in whole plant).							
Control	0	7.84	6.46	5.22	6.57	5.27	**6.27**
GA_3	50	10.47	8.81	7.56	9.00	7.96	**8.76**
NAA	50	8.07	7.05	6.00	7.01	5.57	**6.74**
B_9	50	8.99	7.46	5.91	8.70	7.25	**7.66**
Mean		**8.84**	**7.45**	**6.17**	**7.82**	**6.51**	**7.36**

Table (43): Changes in nitrogen in roots (g/plant) of sugar beet plant, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 and B_9 levels (season 2000/2001) .

Heavy Metals (HM) (mg/l) / Growth Regulator (GR) (mg/l)		Control 0	Cd 50	Cd 100	Pb 50	Pb 100	Mean
		90 days after sowing					
Control	**0**	1.14	0.94	0.75	1.00	0.94	**0.95**
GA_3	**50**	1.40	1.08	1.09	1.23	1.12	**1.18**
	100	1.73	1.21	0.65	1.44	1.26	**1.26**
B_9	**50**	1.36	1.21	1.23	0.70	0.67	**1.03**
	100	1.41	1.30	1.19	0.79	0.70	**1.08**
Mean		**1.41**	**1.15**	**0.98**	**1.03**	**0.94**	**1.10**
		120 days after sowing					
Control	**0**	3.28	2.72	2.04	1.68	1.29	**2.20**
GA_3	**50**	4.00	3.14	2.87	2.48	2.35	**2.97**
	100	4.37	3.57	3.04	2.82	2.65	**3.29**
B_9	**50**	3.78	2.26	1.62	2.88	2.68	**2.64**
	100	3.98	2.49	1.73	3.16	2.74	**2.82**
Mean		**3.88**	**2.84**	**2.26**	**2.60**	**2.34**	**2.78**
		210 days after sowing					
Control	**0**	3.14	2.46	1.12	1.67	0.96	**1.87**
GA_3	**50**	2.80	2.96	1.78	2.13	1.89	**2.31**
	100	4.27	3.84	1.85	2.25	2.08	**2.86**
B_9	**50**	2.67	1.90	1.70	2.51	2.25	**2.21**
	100	2.78	1.93	1.66	3.05	2.48	**2.38**
Mean		**3.13**	**2.62**	**1.62**	**2.32**	**1.93**	**2.33**

Table (44): Changes in nitrogen in leaves (g/plant) of sugar beet plant, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 and B_9 levels (season 2000/2001).

Heavy Metals (HM) (mg/l) / Growth Regulator (GR) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	1.99	1.71	1.52	2.05	1.56	**1.77**
GA_3	50	1.80	2.05	1.93	2.13	1.78	**1.94**
	100	2.94	2.41	1.92	2.33	2.16	**2.35**
B_9	50	2.87	2.04	1.72	2.08	1.85	**2.11**
	100	2.80	2.52	2.82	1.90	1.95	**2.40**
Mean		**2.48**	**2.15**	**1.98**	**2.10**	**1.86**	**2.11**
120 days after sowing							
Control	0	2.57	2.15	1.94	2.31	1.89	**2.17**
GA_3	50	2.88	2.45	1.90	2.51	2.25	**2.40**
	100	3.19	2.65	2.24	2.55	2.33	**2.59**
B_9	50	2.08	2.25	1.84	1.81	1.75	**1.95**
	100	2.97	2.38	2.13	2.25	1.88	**2.32**
Mean		**2.74**	**2.38**	**2.01**	**2.29**	**2.02**	**2.29**
210 days after sowing							
Control	0	4.73	2.91	2.46	3.96	3.64	**3.54**
GA_3	50	6.05	3.84	2.78	4.61	4.34	**4.32**
	100	7.18	3.59	3.59	4.90	4.55	**4.76**
B_9	50	5.65	4.12	2.56	3.87	3.61	**3.96**
	100	6.49	4.58	2.83	4.23	4.36	**4.50**
Mean		**6.02**	**3.81**	**2.84**	**4.31**	**4.10**	**4.22**

Table (45): Changes in nitrogen in whole plant (g/plant) of sugar beet plant, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 and B_9 levels (season 2000/2001).

Heavy Metals (HM) (mg/l) / Growth Regulator (GR) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	3.13	2.68	2.27	3.05	2.50	**2.73**
GA_3	50	3.20	3.13	3.02	3.36	2.90	**3.12**
	100	4.67	3.62	2.57	3.77	3.42	**3.61**
B_9	50	4.23	3.25	2.95	2.78	2.52	**3.15**
	100	4.21	3.82	4.01	2.69	2.65	**3.48**
Mean		**3.89**	**3.30**	**2.96**	**3.13**	**2.80**	**3.22**
120 days after sowing							
Control	0	5.85	4.87	3.98	3.99	3.18	**4.37**
GA_3	50	6.88	5.59	4.77	4.99	4.60	**5.37**
	100	7.56	6.22	5.28	5.37	4.98	**5.88**
B_9	50	5.86	4.51	3.46	4.69	4.43	**4.59**
	100	6.95	4.87	3.86	5.41	4.62	**5.14**
Mean		**6.62**	**5.21**	**4.27**	**4.89**	**4.36**	**5.07**
210 days after sowing							
Control	0	7.87	5.37	3.58	5.63	4.60	**5.41**
GA_3	50	8.85	6.80	4.56	6.74	6.23	**6.64**
	100	11.45	7.43	5.44	7.15	6.6.3	**7.87**
B_9	50	8.32	6.02	4.26	6.38	5.86	**6.17**
	100	9.27	6.51	4.49	7.28	6.84	**6.88**
Mean		**9.15**	**6.43**	**4.47**	**6.64**	**5.88**	**6.59**

Table (46): Changes in phosphorus (g/plant) of sugar beet plant, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 and B_9 levels (season 1999/2000).

Heavy metals (mg/l) / Growth regulator (mg/l)		Control	Cd		Pb		Mean
		0	20	50	20	50	
120 days after sowing (in root).							
Control	0	0.33	0.27	0.29	0.31	0.29	**0.30**
GA_3	50	0.42	0.41	0.37	0.39	0.37	**0.39**
NAA	50	0.35	0.34	0.27	0.29	0.27	**0.30**
B_9	50	0.41	0.38	0.36	0.35	0.33	**0.37**
Mean		**0.38**	**0.35**	**0.32**	**0.34**	**0.32**	**0.34**
210 days after sowing (in root).							
Control	0	0.47	0.43	0.41	0.44	0.42	**0.43**
GA_3	50	0.58	0.50	0.47	0.52	0.48	**0.51**
NAA	50	0.47	0.44	0.37	0.46	0.42	**0.43**
B_9	50	0.49	0.44	0.43	0.51	0.49	**0.47**
Mean		**0.50**	**0.45**	**0.42**	**0.48**	**0.45**	**0.46**
120 days after sowing(in leaves).							
Control	0	0.24	0.23	0.22	0.24	0.21	**0.23**
GA_3	50	0.30	0.27	0.26	0.28	0.26	**0.27**
NAA	50	0.25	0.24	0.22	0.24	0.22	**0.23**
B_9	50	0.28	0.15	0.14	0.26	0.25	**0.22**
Mean		**0.27**	**0.22**	**0.21**	**0.26**	**0.24**	**0.24**
210 days after sowing (in leaves).							
Control	0	0.45	0.39	0.31	0.45	0.40	**0.40**
GA_3	50	0.56	0.53	0.46	0.56	0.53	**0.53**
NAA	50	0.53	0.46	0.39	0.46	0.48	**0.46**
B_9	50	0.60	0.57	0.51	0.55	0.54	**0.55**
Mean		**0.54**	**0.49**	**0.42**	**0.51**	**0.49**	**0.49**
120 days after sowing (in whole plant).							
Control	0	0.57	0.50	0.51	0.55	0.50	**0.53**
GA_3	50	0.72	0.68	0.63	0.67	0.63	**0.67**
NAA	50	0.60	0.58	0.49	0.53	0.49	**0.54**
B_9	50	0.69	0.53	0.50	0.61	0.58	**0.58**
Mean		**0.65**	**0.57**	**0.53**	**0.59**	**0.55**	**0.58**
210 days after sowing (in whole plant).							
Control	0	0.92	0.82	0.72	0.89	0.82	**0.83**
GA_3	50	1.14	1.03	0.93	1.08	1.01	**1.04**
NAA	50	1.00	0.90	0.76	0.92	0.90	**0.90**
B_9	50	1.09	1.01	0.94	1.06	1.03	**1.03**
Mean		**1.04**	**0.94**	**0.84**	**0.99**	**0.94**	**0.95**

Table (47): Changes in phosphorus in roots (g/plant) of sugar beet plant, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 and B_9 levels (season 2000/2001).

Heavy metals (mg/l) / Growth regulator (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	0.170	0.119	0.108	0.139	0.121	**0.131**
GA_3	50	0.203	0.145	0.117	0.162	0.144	**0.154**
	100	0.254	0.173	0.136	0.224	0.194	**0.196**
B_9	50	0.194	0.168	0.125	0.151	0.127	**0.153**
	100	0.233	0.177	0.126	0.143	0.127	**0.161**
Mean		**0.211**	**0.156**	**0.122**	**0.164**	**0.143**	**0.159**
120 days after sowing							
Control	0	0.361	0.319	0.278	0.315	0.309	**0.316**
GA_3	50	0.468	0.378	0.321	0.389	0.352	**0.382**
	100	0.495	0.430	0.407	0.450	0.411	**0.439**
B_9	50	0.390	0.343	0.285	0.377	0.349	**0.349**
	100	0.442	0.381	0.342	0.426	0.368	**0.392**
Mean		**0.431**	**0.370**	**0.327**	**0.391**	**0.358**	**0.375**
210 days after sowing							
Control	0	0.495	0.435	0.374	0.391	0.307	**0.400**
GA_3	50	0.532	0.508	0.449	0.440	0.383	**0.462**
	100	0.594	0.561	0.505	0.489	0.474	**0.525**
B_9	50	0.529	0.457	0.413	0.533	0.464	**0.479**
	100	0.551	0.484	0.439	0.602	0.538	**0.523**
Mean		**0.540**	**0.489**	**0.436**	**0.491**	**0.433**	**0.478**

Table (48): Changes in phosphorus in leaves (g/plant) of sugar beet plant, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 and B_9 levels (season 2000/2001).

Growth regulator (mg/l) \ Heavy metals (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
		90 days after sowing					
Control	0	0.171	0.175	0.109	0.148	0.129	**0.146**
GA_3	50	0.179	0.178	0.159	0.174	0.140	**0.166**
	100	0.257	0.174	0.117	0.191	0.161	**0.180**
B_9	50	0.207	0.162	0.145	0.159	0.128	**0.160**
	100	0.198	0.173	0.159	0.159	0.144	**0.167**
Mean		**0.202**	**0.172**	**0.138**	**0.166**	**0.140**	**0.164**
		120 days after sowing					
Control	0	0.342	0.275	0.221	0.275	0.244	**0.271**
GA_3	50	0.361	0.312	0.247	0.319	0.275	**0.303**
	100	0.394	0.335	0.283	0.337	0.352	**0.340**
B_9	50	0.352	0.255	0.222	0.303	0.309	**0.288**
	100	0.370	0.287	0.238	0.327	0.351	**0.315**
Mean		**0.364**	**0.293**	**0.242**	**0.312**	**0.306**	**0.303**
		210 days after sowing					
Control	0	0.585	0.355	0.272	0.448	0.401	**0.412**
GA_3	50	0.667	0.446	0.314	0.480	0.457	**0.473**
	100	0.829	0.477	0.368	0.552	0.530	**0.551**
B_9	50	0.671	0.475	0.340	0.454	0.426	**0.473**
	100	0.763	0.531	0.403	0.483	0.477	**0.531**
Mean		**0.703**	**0.457**	**0.339**	**0.483**	**0.458**	**0.488**

Table (49): Changes in phosphorus in whole plant (g/plant) of sugar beet plant, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 and B_9 levels (season 2000/2001).

Growth regulator (mg/l) \ Heavy metals (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	0.341	0.270	0.217	0.287	0.250	**0.273**
GA_3	50	0.382	0.323	0.276	0.336	0.284	**0.320**
	100	0.511	0.347	0.253	0.415	0.355	**0.376**
B_9	50	0.401	0.330	0.270	0.310	0.256	**0.313**
	100	0.431	0.350	0.285	0.302	0.271	**0.328**
Mean		**0.413**	**0.324**	**0.260**	**0.330**	**0.283**	**0.322**
120 days after sowing							
Control	0	0.703	0.594	0.499	0.590	0.554	**0.588**
GA_3	50	0.829	0.690	0.568	0.708	0.627	**0.684**
	100	0.889	0.765	0.690	0.787	0.763	**0.779**
B_9	50	0.742	0.598	0.507	0.680	0.658	**0.637**
	100	0.812	0.668	0.576	0.753	0.719	**0.706**
Mean		**0.795**	**0.663**	**0.568**	**0.704**	**0.664**	**0.679**
210 days after sowing							
Control	0	1.08	0.79	0.646	0.84	0.708	**0.813**
GA_3	50	1.20	0.95	0.763	0.92	0.840	**0.935**
	100	1.42	1.04	0.873	1.04	1.00	**1.075**
B_9	50	1.20	0.93	0.753	0.99	0.890	**0.953**
	100	1.31	1.02	0.842	1.09	1.02	**1.056**
Mean		**1.242**	**0.946**	**0.775**	**0.976**	**0.892**	**0.966**

Table (50): Changes in potassium (g/plant) of sugar beet plant, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3, NAA and B_9 levels (season 1999/2000).

Growth regulator (mg/l) \ Heavy metals (mg/l)		Control	Cd		Pb		Mean
		0	20	50	20	50	
120 days after sowing (in root).							
Control	0	2.52	2.13	2.04	2.40	2.01	**2.22**
GA_3	50	3.26	3.05	2.60	2.87	2.50	**2.86**
NAA	50	3.05	2.48	1.92	2.35	1.58	**2.28**
B_9	50	3.24	2.78	2.51	2.59	2.50	**2.72**
Mean		**3.02**	**2.61**	**2.27**	**2.55**	**2.15**	**2.52**
210 days after sowing (in root).							
Control	0	2.78	2.44	1.93	2.65	2.15	**2.39**
GA_3	50	4.14	3.70	2.87	3.32	3.18	**3.44**
NAA	50	3.78	3.44	2.72	2.77	2.13	**2.97**
B_9	50	3.91	3.42	2.86	2.76	2.67	**3.12**
Mean		**3.65**	**3.25**	**2.60**	**2.88**	**2.53**	**2.98**
120 days after sowing (in leaves).							
Control	0	2.60	2.35	2.12	2.42	2.18	**2.33**
GA_3	50	3.20	2.94	2.72	2.29	3.08	**2.85**
NAA	50	2.78	2.75	2.63	2.51	2.26	**2.59**
B_9	50	3.21	2.83	2.75	3.05	2.80	**2.93**
Mean		**2.95**	**2.72**	**2.56**	**2.57**	**2.58**	**2.67**
210 days after sowing (in leaves).							
Control	0	3.98	3.43	3.09	3.46	3.07	**3.41**
GA_3	50	5.05	4.08	3.26	4.54	3.80	**4.15**
NAA	50	4.53	3.71	3.14	4.17	3.39	**3.79**
B_9	50	4.59	4.14	3.30	4.79	4.14	**4.19**
Mean		**4.54**	**3.84**	**3.20**	**4.24**	**3.60**	**3.88**
120 days after sowing (in whole plant).							
Control	0	5.12	4.48	4.16	4.82	4.19	**4.55**
GA_3	50	6.46	5.99	5.32	5.16	5.58	**5.70**
NAA	50	5.83	5.23	4.55	4.86	3.84	**4.86**
B_9	50	6.45	5.61	5.26	5.64	5.30	**5.65**
Mean		**5.97**	**5.33**	**4.82**	**5.12**	**4.73**	**5.19**
210 days after sowing (in whole plant).							
Control	0	6.76	5.87	5.02	6.11	5.22	**5.80**
GA_3	50	9.19	7.78	6.13	7.86	6.98	**7.59**
NAA	50	8.31	7.15	5.86	6.94	5.52	**6.76**
B_9	50	8.50	7.56	6.16	7.55	6.81	**7.32**
Mean		**8.19**	**7.09**	**5.79**	**7.12**	**6.13**	**6.86**

Table (51): Changes in potassium in roots (g/plant) of sugar beet plant, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 and B_9 levels (season 2000/2001).

Heavy metals (mg/l) / Growth regulator (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	1.60	1.08	0.67	1.36	1.22	**1.19**
GA_3	50	1.96	1.35	1.16	1.93	1.63	**1.61**
	100	2.33	1.23	1.28	2.53	1.97	**1.87**
B_9	50	1.58	1.54	1.06	1.36	1.36	**1.38**
	100	1.91	1.74	1.40	1.68	1.48	**1.64**
Mean		**1.88**	**1.39**	**1.11**	**1.77**	**1.53**	**1.54**
120 days after sowing							
Control	0	2.81	2.42	1.76	2.46	2.07	**2.30**
GA_3	50	3.48	2.98	2.29	2.99	2.25	**2.80**
	100	4.00	3.23	2.58	3.64	2.31	**3.15**
B_9	50	2.97	2.57	2.13	2.61	2.56	**2.57**
	100	2.97	2.83	2.31	3.02	2.61	**2.75**
Mean		**3.25**	**2.81**	**2.21**	**2.94**	**2.36**	**2.71**
210 days after sowing							
Control	0	3.40	3.19	2.24	2.69	2.60	**2.82**
GA_3	50	4.18	4.03	3.30	4.04	3.41	**3.79**
	100	5.79	5.61	3.96	5.12	3.68	**4.83**
B_9	50	4.04	3.43	3.34	3.31	2.46	**3.32**
	100	5.08	4.39	3.65	4.29	3.28	**4.14**
Mean		**4.50**	**4.13**	**3.30**	**3.89**	**3.09**	**3.78**

Table (52): Changes in potassium in leaves (g/plant) of sugar beet plant, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 and B_9 levels (season 2000/2001).

Heavy metals (mg/l) / Growth regulator (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	1.84	1.53	1.27	1.42	0.98	**1.41**
GA_3	50	2.21	2.05	1.88	1.87	1.39	**1.88**
	100	3.37	2.41	1.97	2.37	1.62	**2.35**
B_9	50	2.24	1.87	1.66	1.86	1.36	**1.80**
	100	2.67	2.21	2.04	1.89	1.63	**2.09**
Mean		**2.47**	**2.01**	**1.76**	**1.88**	**1.40**	**1.90**
120 days after sowing							
Control	0	3.00	2.53	2.07	2.60	2.30	**2.50**
GA_3	50	3.34	2.77	1.69	3.18	2.61	**2.72**
	100	3.68	2.91	2.16	3.32	2.83	**2.98**
B_9	50	3.10	2.83	1.80	3.10	2.86	**2.74**
	100	3.50	3.18	2.01	3.84	3.34	**3.17**
Mean		**3.32**	**2.84**	**1.95**	**3.21**	**2.79**	**2.82**
210 days after sowing							
Control	0	4.50	3.29	2.84	5.36	4.43	**4.08**
GA_3	50	5.32	4.04	3.79	5.37	4.10	**4.52**
	100	7.30	4.16	4.31	5.76	4.75	**5.26**
B_9	50	5.44	3.87	3.02	4.22	2.93	**3.90**
	100	6.09	4.78	3.88	5.06	3.31	**4.62**
Mean		**5.73**	**4.03**	**3.57**	**5.15**	**3.90**	**4.48**

Table (53): Changes in potassium in whole plant (g/plant) of sugar beet plant, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 and B_9 levels (season 2000/2001).

Growth regulator (mg/l) \ Heavy metals (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	3.44	2.61	1.94	2.78	2.20	**2.59**
GA_3	50	4.17	3.40	3.04	3.80	3.02	**3.49**
	100	5.70	3.64	3.25	4.90	3.59	**4.22**
B_9	50	3.82	3.41	2.72	3.22	2.72	**3.18**
	100	4.58	3.95	3.44	3.57	3.11	**3.73**
Mean		**4.34**	**3.40**	**2.88**	**3.65**	**2.93**	**3.44**
120 days after sowing							
Control	0	5.81	4.95	3.83	5.06	4.37	**4.80**
GA_3	50	6.82	5.75	3.98	6.17	4.86	**5.52**
	100	7.68	6.23	4.74	6.96	5.14	**6.15**
B_9	50	6.07	5.40	3.93	5.91	5.42	**5.35**
	100	6.47	6.01	4.32	6.86	5.95	**5.92**
Mean		**6.57**	**5.67**	**4.16**	**6.19**	**5.15**	**5.55**
210 days after sowing							
Control	0	7.90	6.48	5.08	8.05	7.03	**6.91**
GA_3	50	9.50	8.07	7.09	9.41	7.51	**8.32**
	100	13.09	9.77	8.27	11.09	8.43	**10.13**
B_9	50	9.48	7.30	6.36	7.53	5.39	**7.21**
	100	11.17	9.17	7.53	9.35	6.59	**8.76**
Mean		**10.23**	**8.16**	**6.87**	**9.09**	**6.99**	**8.27**

Table (54): Changes in sodium (g/plant) of sugar beet plant, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 and B_9 levels (season 1999/2000) .

Heavy metals (mg/l) / Growth regulator (mg/l)		Control	Cd		Pb		Mean
		0	20	50	20	50	
120 days after sowing (in root)							
Control	0	0.28	0.21	0.22	0.26	0.23	**0.24**
GA_3	50	0.39	0.39	0.34	0.38	0.34	**0.37**
NAA	50	0.32	0.26	0.20	0.28	0.22	**0.26**
B_9	50	0.39	0.36	0.28	0.38	0.32	**0.35**
Mean		**0.35**	**0.31**	**0.26**	**0.33**	**0.28**	**0.30**
210 days after sowing (in root)							
Control	0	0.37	0.33	0.28	0.37	0.34	**0.34**
GA_3	50	0.49	0.44	0.34	0.50	0.41	**0.44**
NAA	50	0.37	0.31	0.24	0.31	0.22	**0.29**
B_9	50	0.46	0.38	0.32	0.48	0.42	**0.41**
Mean		**0.42**	**0.37**	**0.30**	**0.42**	**0.35**	**0.37**
120 days after sowing (in leaves)							
Control	0	0.61	0.55	0.51	0.55	0.51	**0.55**
GA_3	50	0.73	0.65	0.61	0.69	0.65	**0.67**
NAA	50	0.63	0.59	0.55	0.54	0.49	**0.56**
B_9	50	0.75	0.66	0.61	0.61	0.56	**0.64**
Mean		**0.68**	**0.61**	**0.57**	**0.60**	**0.55**	**0.60**
210 days after sowing (in leaves)							
Control	0	0.62	0.51	0.46	0.55	0.46	**0.52**
GA_3	50	0.78	0.65	0.56	0.73	0.60	**0.66**
NAA	50	0.64	0.53	0.39	0.59	0.50	**0.53**
B_9	50	0.70	0.64	0.57	0.72	0.66	**0.66**
Mean		**0.69**	**0.58**	**0.50**	**0.65**	**0.56**	**0.59**
120 days after sowing (in whole plant)							
Control	0	0.89	0.76	0.73	0.81	0.74	**0.79**
GA_3	50	1.12	1.04	0.95	1.07	0.99	**1.03**
NAA	50	0.95	0.85	0.75	0.82	0.71	**0.82**
B_9	50	1.14	1.02	0.89	0.99	0.88	**0.98**
Mean		**1.03**	**0.92**	**0.83**	**0.92**	**0.83**	**0.91**
210 days after sowing (in whole plant)							
Control	0	0.99	0.84	0.74	0.92	0.80	**0.86**
GA_3	50	1.27	1.09	0.90	1.23	1.01	**1.10**
NAA	50	1.01	0.84	0.63	0.90	0.72	**0.82**
B_9	50	1.16	1.02	0.89	1.20	1.08	**1.07**
Mean		**1.11**	**0.95**	**0.79**	**1.06**	**0.90**	**0.96**

Table (55): Changes in sodium in roots (g/plant) of sugar beet plant, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 and B_9 levels (season 2000/2001) .

Heavy metals (mg/l) / Growth regulator (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	**0**	0.20	0.10	0.08	0.15	0.12	**0.13**
GA_3	**50**	0.27	0.14	0.13	0.19	0.15	**0.18**
	100	0.33	0.18	0.19	0.29	0.19	**0.24**
B_9	**50**	0.21	0.18	0.16	0.16	0.15	**0.17**
	100	0.25	0.22	0.18	0.23	0.19	**0.21**
Mean		**0.25**	**0.16**	**0.15**	**0.20**	**0.16**	**0.19**
120 days after sowing							
Control	**0**	0.37	0.33	0.27	0.31	0.25	**0.31**
GA_3	**50**	0.49	0.37	0.30	0.37	0.31	**0.37**
	100	0.56	0.45	0.34	0.48	0.33	**0.43**
B_9	**50**	0.45	0.40	0.31	0.33	0.28	**0.35**
	100	0.51	0.42	0.38	0.39	0.35	**0.41**
Mean		**0.48**	**0.39**	**0.32**	**0.38**	**0.30**	**0.37**
210 days after sowing							
Control	**0**	0.47	0.34	0.31	0.43	0.32	**0.37**
GA_3	**50**	0.50	0.38	0.36	0.42	0.43	**0.42**
	100	0.64	0.56	0.42	0.57	0.51	**0.54**
B_9	**50**	0.52	0.34	0.33	0.51	0.36	**0.41**
	100	0.68	0.41	0.33	0.59	0.37	**0.48**
Mean		**0.56**	**0.41**	**0.35**	**0.50**	**0.40**	**0.44**

Table (56): Changes in sodium in leaves (g/plant) of sugar beet plant, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 and B_9 levels (season 2000/2001) .

Growth regulator (mg/l) \ Heavy metals (mg/l)		Control 0	Cd 50	Cd 100	Pb 50	Pb 100	Mean
		90 days after sowing					
Control	0	0.527	0.454	0.385	0.463	0.431	**0.45**
GA_3	50	0.534	0.556	0.488	0.550	0.483	**0.52**
	100	0.761	0.632	0.470	0.654	0.566	**0.62**
B_9	50	0.627	0.516	0.507	0.523	0.464	**0.53**
	100	0.617	0.572	0.554	0.545	0.503	**0.56**
Mean		**0.61**	**0.55**	**0.48**	**0.55**	**0.49**	**0.54**
		120 days after sowing					
Control	0	0.583	0.460	0.394	0.570	0.460	**0.49**
GA_3	50	0.668	0.554	0.465	0.618	0.563	**0.57**
	100	0.813	0.795	0.556	0.789	0.618	**0.71**
B_9	50	0.646	0.551	0.486	0.595	0.493	**0.55**
	100	0.754	0.635	0.520	0.785	0.674	**0.67**
Mean		**0.69**	**0.60**	**0.48**	**0.67**	**0.56**	**0.60**
		210 days after sowing					
Control	0	0.593	0.444	0.358	0.508	0.431	**0.47**
GA_3	50	0.732	0.551	0.457	0.470	0.539	**0.55**
	100	0.939	0.606	0.500	0.486	0.593	**0.62**
B_9	50	0.654	0.463	0.360	0.586	0.435	**0.50**
	100	0.783	0.403	0.443	0.661	0.507	**0.56**
Mean		**0.74**	**0.49**	**0.42**	**0.54**	**0.50**	**0.54**

Table (57): Changes in sodium in whole plant (g/plant) of sugar beet plant, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 and B_9 levels (season 2000/2001) .

Growth regulator (mg/l) \ Heavy metals (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	0.727	0.554	0.465	0.613	0.551	**0.582**
GA_3	50	0.804	0.696	0.618	0.740	0.633	**0.698**
	100	1.090	0.812	0.660	0.944	0.756	**0.852**
B_9	50	0.837	0.696	0.667	0.683	0.614	**0.699**
	100	0.867	0.792	0.734	0.775	0.693	**0.772**
Mean		**0.865**	**0.710**	**0.629**	**0.751**	**0.649**	**0.721**
120 days after sowing							
Control	0	0.953	0.790	1.761	0.880	0.710	**1.019**
GA_3	50	1.158	0.924	0.765	0.988	0.873	**0.942**
	100	1.373	1.245	0.896	1.269	0.948	**1.146**
B_9	50	1.096	0.951	0.796	0.925	0.773	**0.908**
	100	1.264	1.055	0.900	1.175	1.024	**1.084**
Mean		**1.169**	**0.993**	**1.024**	**1.047**	**0.866**	**1.020**
210 days after sowing							
Control	0	1.063	2.173	0.668	0.938	0.751	**1.119**
GA_3	50	1.232	0.931	0.817	0.890	0.969	**0.968**
	100	1.579	1.166	0.920	1.056	1.103	**1.165**
B_9	50	1.174	0.803	0.690	1.090	0.795	**0.910**
	100	1.463	0.813	0.773	1.251	0.877	**1.035**
Mean		**1.302**	**1.177**	**0.774**	**1.045**	**0.899**	**1.039**

According to the aforementioned results the following discussions may be concluded:

a) Cd or Pb exposure of sugar beet plants led to substantial changes in nutrient composition in both roots and shoots as it was alter the accumulation of N, P, K and Na in both roots and shoots of sugar beet plant . In other words, Cd or Pb disturb the uptake, translocation and accumulation of the tested elements and that lead to the unbalanced nutrients. This conclusion was also obtained by lot of workers working on different plant species among them **Obata and Umebayashi (1997), Larsson *et al.*, (1998), Michalska and Asp (2001) and El-Nabarawy (2002).** This disturbance is completely varied within plant species and that partially related to the degree of plant sensitivity to the toxicity of Cd .

b) the accumulation of different studied nutrients per plant must be either related to the reduction effects of Cd or Pb on plant growth or maybe due to the capacity of the elements uptake and or the translocation regulation effects of Cd or Pb within plant organs. In conclusion on the manner in which the toxic element and nutrient in relation to both the concentration of the nutrient elements and to the plant root absorption area must be taken into account (**Greger *et al.*, 1991**) Finally, Cd or Pb causes a troublness in the metabolic nutrient uptake and thus contribute to the reduced sugar beet plant growth .

5- Dealing with the effect of growth regulators lie GA_3, NAA and B_9 on N, P, K and Na (g/plant) in leaves, roots and whole plants data cleared that growth regulators under tested increased the total actual contents of N, P, K and Na as compared with control. It is worthy to note that GA_3 followed by B_9 gave the higher increase than NAA.

6- the interaction between growth regulators with heavy metals under tested improved the negative effect of Cd and Pb on these trait.

Heavy metals Cd and Pb concentration:

Tables (58,59,60,61,62 and 63) show the effect of Cd and Pb at different rates on Cd (µg/g D.W.)and Pb (mg/g D.W.) in various parts of sugar beet plant in two seasons. With regard to the effect of Cd , it could be mention that, control (untreated plants) and Pb treated plants seamed to be free completely from Cd . This means that the irrigated water and the soil in which plants growth where free from Cd . Data also showed that Cd concentration in leaves and roots was increased with increasing the concentration of Cd . With regard to the effect of Pb, the data showed that Cd concentration in leaves and roots in all sampling dates in two seasons was slight decreased by increasing Pb application, while Pb concentration was increased under the same conditions.

Foliar spray with growth regulators, i.e. GA_3, NAA and B_9 increased Cd and Pb concentration in roots and leaves of sugar beet plants in two seasons.

Data presented in the same tables clearly prove that application of growth regulators GA_3, NAA or B_9 reversed the harmful effects of Cd and Pb of sugar beet plants.

Quality and yields:

Data presented in Tables (64 and 65) illustrated that Cd or Pb at different rates decreased juice partly percentage, root yield and sugar yield (ton/fed) at harvest time (210 days from sowing) in two seasons. This negative effect increased by increasing the concentration of Cd or Pb, Cd was more harmful in reducing sugar beet yield than Pb. The addition of growth regulators lie GA_3, NAA or B_9 increased these above traits, also in activated Cd and Pb respectively, which have toxic effect on sugar beet yield . These results are in

Table (58):Changes in Cadmium (µg/gD.W) of sugar beet plant as affected by combined foliar sprays of different Cd rates with variable GA_3,NAA and B_9 levels (season 1999/2000)

Growth Regulator mg/L \ Element mg/L	Cd							
	In root							
	120 days				210 days			
	0	**20**	**50**	**Mean**	**0**	**20**	**50**	**Mean**
Control	Nil.	7.5	11	**6.2**	Nil	5.5	7.0	**4.2**
GA_3 50	Nil	5.0	8.5	**4.5**	Nil	4.0	5.5	**3.2**
NAA 50	Nil	6.5	10.	**5.5**	Nil	5.5	9.0	**4.8**
B_9 50	Nil	5.0	8.0	**4.3**	Nil	4.0	5.0	**3.0**
Mean*	Nil	**5.5**	**8.8**	**4.8**	Nil	4.5	6.5	**3.7**
	In leave							
Control	Nil	10	16.0	**8.7**	Nil	10.5	14.0	**8.2**
GA_3 50	Nil	8.0	13.5	**7.2**	Nil	5.0	5.5	**3.5**
NAA 50	Nil	9.5	14.0	**7.8**	Nil	9.0	10.0	**6.3**
B_9 50	Nil	7.5	11.5	**6.3**	Nil	8.0	8.5	**5.5**
Mean*	Nil	**8.3**	**13.0**	**7.1**	Nil	**7.3**	**8.0**	**5.1**
In whole plant								
Control	Nil	17.5	27.0	**14.8**	Nil	16.0	21.0	**12.3**
GA_3 50	Nil	13.0	22.0	**11.7**	Nil	9.0	11.0	**6.7**
NAA 50	Nil	16.0	24.0	**13.3**	Nil	14.5	19.0	**11.2**
B_9 50	Nil	12.5	19.5	**10.7**	Nil	12.0	13.5	**8.5**
Mean*	Nil	**13.8**	**21.8**	**11.9**	Nil	11.8	14.5	**8.8**

* Without Control (0 mg /L)

ble (59): Changes in cadmium (µg/g D. W) of sugar beet plant as affected by combined foliar sprays of different Cd rates with variable GA_3 and B_9 levels (season 2000/2001).

Elements mg/L / rowth ulator mg/L	Cd (in roots)											
	90 days			Mean	120 days			Mean	210 days			Mean
	0	50	100		0	50	100		0	50	100	
ontrol	Nil	6.50	12.00	**6.17**	Nil	7.50	13.00	**6.83**	Nil	5.50	9.00	**4.83**
A$_3$ 50	Nil	5.00	9.00	**4.67**	Nil	5.50	10.00	**5.17**	Nil	5.00	7.50	**4.17**
A$_3$ 100	Nil	3.50	5.50	**3.00**	Nil	4.50	6.50	**3.67**	Nil	3.50	4.50	**2.67**
Mean*	Nil	**4.25**	**7.25**	**3.83**	Nil	**5.00**	**8.25**	**4.42**	Nil	4.25	6.00	**3.42**
$_9$ 50	Nil	6.00	8.00	**4.67**	Nil	5.50	7.00	**4.17**	Nil	4.00	6.50	**3.50**
$_9$ 100	Nil	4.00	5.50	**3.17**	Nil	5.00	6.50	**3.83**	Nil	3.00	4.00	**2.33**
Mean*	Nil	**5.00**	**6.75**	**2.87**	Nil	**5.25**	**6.75**	**4.00**	Nil	**3.50**	**5.25**	**2.92**
All means	Nil	**4.63**	**7.00**	**5.42**	Nil	**5.13**	**7.50**	**3.72**	Nil	**3.88**	**5.63**	**3.17**
	Cd (in leaves)											
ontrol	Nil	11.00	20.00	**10.33**	Nil	12.00	20.00	**10.67**	Nil	9.00	15.50	**8.17**
A$_3$ 50	Nil	10.00	17.50	**9.17**	Nil	10.00	16.50	**8.83**	Nil	6.00	13.50	**6.50**
A$_3$ 100	Nil	9.00	16.50	**8.50**	Nil	8.50	15.00	**7.83**	Nil	5.00	11.50	**5.50**
Mean*	Nil	**9.50**	**17.00**	**8.83**	Nil	**9.25**	**15.25**	**8.33**	Nil	5.50	12.50	**6.00**
$_9$ 50	Nil	9.50	18.50	**9.33**	Nil	10.00	17.00	**9.00**	Nil	6.00	12.50	**6.17**
$_9$ 100	Nil	8.00	18.50	**8.83**	Nil	9.00	15.50	**8.17**	Nil	5.00	11.00	**5.33**
Mean*	Nil	**8.75**	**18.50**	**9.08**	Nil	**9.50**	**16.25**	**8.58**	Nil	**5.50**	**11.75**	**5.75**
All means	Nil	**9.13**	**17.75**	**8.96**	Nil	**9.38**	**16.00**	**8.46**	Nil	**5.50**	**12.13**	**5.88**
	Cd (in whole plant)											
ontrol	Nil	17.50	32.00	**15.50**	Nil	18.50	33.00	**17.17**	Nil	14.50	24.50	**13.00**
A$_3$ 50	Nil	15.00	26.50	**13.83**	Nil	15.50	26.50	**14.00**	Nil	11.00	21.00	**10.67**
A$_3$ 100	Nil	12.50	22.00	**11.50**	Nil	13.00	21.50	**11.50**	Nil	8.50	16.00	**8.17**
Mean*	Nil	**13.75**	**24.25**	**12.67**	Nil	**14.25**	**24.00**	**12.75**	Nil	9.75	18.50	9.42
$_9$ 50	Nil	15.50	26.50	**14.00**	Nil	15.50	24.00	**13.17**	Nil	10.00	19.00	9.67
$_9$ 100	Nil	12.00	24.00	**12.00**	Nil	14.00	22.00	**12.00**	Nil	8.00	15.00	7.67
Mean*	Nil	**13.75**	25.25	13.00	Nil	14.25	23.00	12.58	Nil	9.00	17.00	8.67
All means	Nil	**13.75**	24.75	12.84	Nil	14.25	23.50	12.67	Nil	9.38	17.75	9.05

Pb was not detected under the used analytical procedure analysis

Table (60) : Changes in lead (mg/g. D.W.) of sugar beet plant, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 and B_9 levels (season 1999/2000) .

Heavy metals (mg/l) / Growth regulator (mg/l)		Control	Cd		Pb		Mean
		0	20	50	20	50	
120 days after sowing (in root)							
Control	0	0.675	0.580	0.555	1.255	1.410	**0.90**
GA_3	50	0.635	0.560	0.500	1.065	1.145	**0.78**
NAA	50	0.650	0.640	0.625	1.225	1.365	**0.90**
B_9	50	0.625	0.580	0.555	1.185	1.255	**0.84**
Mean		**0.65**	**0.59**	**0.56**	**1.18**	**1.29**	**0.85**
210 days after sowing (in root)							
Control	0	0.590	0.560	0.545	0.725	0.810	**0.65**
GA_3	50	0.555	0.535	0.535	0.655	0.745	**0.61**
NAA	50	0.580	0.560	0.540	0.700	0.755	**0.63**
B_9	50	0.550	0.535	0.520	0.615	0.730	**0.59**
Mean		**0.57**	**0.55**	**0.54**	**0.67**	**0.76**	**0.62**
120 days after sowing (in leaves)							
Control	0	1.455	1.415	1.345	1.555	1.695	**1.49**
GA_3	50	1.365	1.315	1.220	1.520	1.595	**1.40**
NAA	50	1.425	1.365	1.330	1.610	1.705	**1.49**
B_9	50	1.345	1.310	1.270	1.505	1.610	**1.41**
Mean		**1.40**	**1.35**	**1.29**	**1.55**	**1.65**	**1.45**
210 days after sowing (in leaves)							
Control	0	0.725	0.665	0.650	0.785	0.845	**0.73**
GA_3	50	0.605	0.590	0.590	0.725	0.735	**0.65**
NAA	50	0.645	0.630	0.615	0.730	0.740	**0.67**
B_9	50	0.665	0.645	0.605	0.725	0.745	**0.68**
Mean		**0.66**	**0.63**	**0.62**	**0.74**	**0.77**	**0.68**
120 days after sowing (in whole plant)							
Control	0	2.130	1.995	1.900	1.900	3.105	**2.21**
GA_3	50	2.000	1.875	1.720	2.585	2.740	**2.18**
NAA	50	2.075	2.005	1.955	2.835	3.070	**2.39**
B_9	50	1.970	1.890	1.825	2.690	2.865	**2.25**
Mean		**2.04**	**1.94**	**1.85**	**2.50**	**2.95**	**2.26**
210 days after sowing (in whole plant)							
Control	0	1.315	1.225	1.195	1.510	1.655	**1.38**
GA_3	50	1.160	1.125	1.125	1.380	1.480	**1.25**
NAA	50	1.225	1.190	1.155	1.430	1.495	**1.30**
B_9	50	1.215	1.180	1.125	1.340	1.475	**1.27**
Mean		**1.23**	**1.18**	**1.15**	**1.42**	**1.53**	**1.30**

Table (61): Changes in lead in roots (mg/g. D.W.) of sugar beet plant, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 and B_9 levels (season 2000/2001) .

Heavy metals (mg/l) / Growth regulator (mg/l)		Control 0	Cd 50	Cd 100	Pb 50	Pb 100	Mean
		90 days after sowing					
Control	0	0.555	0.515	0.505	0.650	0.775	**0.600**
GA_3	50	0.525	0.515	0.500	0.645	0.765	**0.590**
	100	0.510	0.500	0.490	0.625	0.745	**0.574**
B_9	50	0.515	0.505	0.495	0.625	0.780	**0.584**
	100	0.500	0.485	0.480	0.610	0.750	**0.565**
Mean		**0.521**	**0.504**	**0.494**	**0.631**	**0.763**	**0.583**
		120 days after sowing					
Control	0	0.765	0.740	0.725	0.860	0.950	**0.808**
GA_3	50	0.740	0.725	0.720	0.845	0.835	**0.773**
	100	0.710	0.700	0.685	0.705	0.670	**0.694**
B_9	50	0.745	0.715	0.705	0.845	0.890	**0.780**
	100	0.735	0.720	0.690	0.830	0.885	**0.772**
Mean		**0.739**	**0.720**	**0.705**	**0.817**	**0.846**	**0.765**
		210 days after sowing					
Control	0	0.485	0.455	0.435	0.525	0.550	**0.490**
GA_3	50	0.415	0.400	0.380	0.490	0.515	**0.440**
	100	0.400	0.365	0.350	0.480	0.500	**0.419**
B_9	50	0.400	0.395	0.375	0.495	0.510	**0.435**
	100	0.400	0.385	0.365	0.470	0.500	**0.424**
Mean		**0.420**	**0.400**	**0.381**	**0.492**	**0.515**	**0.442**

Table (62) : Changes in lead in leaves (mg/g. D.W.) of sugar beet plant, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 and B_9 levels (season 2000/2001) .

Heavy metals (mg/l) / Growth regulator (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
90 days after sowing							
Control	0	1.015	1.000	0.955	1.330	1.525	**1.165**
GA_3	50	0.965	0.955	0.935	1.165	1.405	**1.085**
	100	0.945	0.930	0.910	0.985	1.245	**1.003**
B_9	50	0.980	0.975	0.940	1.155	1.370	**1.084**
	100	0.965	0.935	0.900	1.050	1.110	**0.992**
Mean		**0.974**	**0.959**	**0.928**	**1.137**	**1.331**	**1.066**
120 days after sowing							
Control	0	1.425	1.400	1.385	1.690	1.755	**1.531**
GA_3	50	1.360	1.255	1.200	1.615	1.655	**1.417**
	100	1.305	1.265	1.245	1.540	1.560	**1.383**
B_9	50	1.385	1.335	1.275	1.620	1.675	**1.458**
	100	1.340	1.280	1.265	1.500	1.575	**1.392**
Mean		**1.363**	**1.307**	**1.274**	**1.593**	**1.644**	**1.436**
210 days after sowing							
Control	0	0.885	0.815	0.705	1.010	1.045	**0.892**
GA_3	50	0.865	0.800	0.650	0.950	0.970	**0.847**
	100	0.760	0.710	0.610	0.900	0.910	**0.778**
B_9	50	0.845	0.800	0.755	0.945	0.980	**0.865**
	100	0.800	0.760	0.720	0.920	0.945	**0.829**
Mean		**0.831**	**0.777**	**0.688**	**0.945**	**0.970**	**0.842**

Table (63): Changes in lead in whole plant (mg/g. D.W.) of sugar beet plant, during different periods of growth, as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 and B_9 levels (season 2000/2001) .

Heavy metals (mg/l) / Growth regulator (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
		90 days after sowing					
Control	**0**	1.570	1.515	1.460	1.980	2.300	**1.765**
GA_3	**50**	1.490	1.470	1.435	1.810	2.170	**1.675**
	100	1.455	1.430	1.400	1.610	1.990	**1.577**
B_9	**50**	1.495	1.480	1.435	1.780	2.150	**1.668**
	100	1.465	1.420	1.380	1.660	1.860	**1.557**
Mean		**1.495**	**1.463**	**1.422**	**1.768**	**2.094**	**1.648**
		120 days after sowing					
Control	**0**	2.190	2.140	2.110	2.550	2.705	**2.339**
GA_3	**50**	2.100	1.980	1.920	0.460	2.490	**1.790**
	100	2.015	1.965	2.430	2.245	2.230	**2.177**
B_9	**50**	2.130	2.050	1.980	2.465	2.575	**2.240**
	100	2.075	2.000	1.955	2.330	2.460	**2.164**
Mean		**2.102**	**2.027**	**2.079**	**2.010**	**2.492**	**2.142**
		210 days after sowing					
Control	**0**	1.370	1.270	1.140	1.535	1.595	**1.382**
GA_3	**50**	1.280	1.200	1.030	1.440	1.485	**1.287**
	100	1.160	1.075	0.960	1.380	1.410	**1.197**
B_9	**50**	1.285	1.195	1.130	1.440	0.990	**1.208**
	100	1.200	1.140	1.085	1.390	1.445	**1.252**
Mean		**1.259**	**1.176**	**1.069**	**1.437**	**1.385**	**1.265**

Table (64): Changes in Juice purity, root yield (ton/fed) and sugar yield(ton/ fed) during harvesting time as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 or B_9 levels (season 1999/2000).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	20	50	20	50	
		Juice purity					
Control	0	80.76	74.31	64.11	80.69	81.15	**76.20**
GA_3	50	82.38	79.16	76.50	79.05	82.90	**80.00**
NAA	50	81.58	80.21	79.30	84.16	83.26	**81.70**
B_9	50	81.20	84.10	82.95	90.17	90.91	**85.87**
Mean		**81.48**	**79.45**	**75.72**	**83.52**	**84.56**	**80.94**
		Root yield					
Control	0	30.70	30.24	29.53	30.16	29.80	**30.09**
GA_3	50	32.96	32.48	32.20	33.11	33.01	**32.75**
NAA	50	31.45	30.80	30.63	29.90	29.57	**30.47**
B_9	50	32.31	31.73	31.55	30.34	30.01	**31.19**
Mean		**31.86**	**31.31**	**30.98**	**30.88**	**30.60**	**31.12**
		Sugar yield					
Control	0	4.79	4.27	3.60	4.92	4.84	**4.48**
GA_3	50	5.55	5.19	4.93	5.58	5.47	**5.34**
NAA	50	4.87	4.62	4.54	4.78	4.68	**4.70**
B_9	50	5.25	5.07	4.97	4.92	4.80	**5.00**
Mean		**5.12**	**4.79**	**4.51**	**5.05**	**4.95**	**4.88**

Table (65):Changes in Juice purity, root yield (ton/feddan) and suger yield(ton/ feddan) during harvesting time as affected by combined foliar sprays of different Cd or Pb rates with variable GA_3 or B_9 levels (season 2000/2001).

Growth Regulator (G.R)(mg/l) \ Heavy Metal (HM) (mg/l)		Control	Cd		Pb		Mean
		0	50	100	50	100	
Juice purity							
Control	0	83.11	77.89	77.67	93.25	88.22	**84.03**
GA_3	50	82.32	79.67	79.77	88.67	87.71	**83.63**
	100	84.21	87.33	87.51	87.00	93.67	**87.94**
B_9	50	79.94	78.47	81.73	97.18	78.47	**83.16**
	100	85.96	82.67	81.59	92.22	84.09	**85.31**
Mean		**83.11**	**81.21**	**81.65**	**91.66**	**86.43**	**84.81**
Root yield							
Control	0	33.15	32.28	31.25	32.56	31.78	**32.20**
GA_3	50	33.93	33.18	32.31	33.54	33.04	**33.20**
	100	35.41	34.44	33.66	34.47	33.46	**34.29**
B9	50	33.29	32.06	31.56	33.26	32.56	**32.55**
	100	33.60	33.07	31.89	35.45	33.04	**33.41**
Mean		**33.88**	**33.01**	**32.13**	**33.86**	**32.78**	**33.13**
Sugar yield							
Control	0	4.96	4.53	4.37	4.94	4.56	**4.67**
GA_3	50	5.31	4.76	4.54	5.14	4.81	**4.91**
	100	5.67	5.41	5.10	5.39	5.20	**5.35**
B9	50	4.79	4.78	4.46	5.49	4.67	**4.84**
	100	4.99	4.92	4.57	5.88	4.88	**5.05**
Mean		**5.14**	**4.88**	**4.61**	**5.37**	**4.82**	**4.96**

accordance with, **Aery and Sarkar (1991)** and **Nagoor and Vyas (1998)** and **Sorial and Abdel-fattah (2001)** who reported that higher Cd and Pb concentration significantly decreased the yield of kidney beans.