Conclusion and summary

concluded that GA_3 seemed to have slight increasing effects on root length, and root diameter. This effect increased with increasing its rate.

3- 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.

4- With regard to the interprentation 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.

5- 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, was gained. 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.

6- 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. GA_3 may be exhibited the most stimulatory effects in this respect, even under depressive combined effects of heavy metals. Most used growth regulators minimized the inhibitory effects of Cd or Pb on the functional photosynthetic area.

7- The tested treatments of Cd or Pb and the used growth regulators rates as well as interactions between them affected

the grade of swolling shape of roots during different periods of growth. Under lead treatments the sugar beet root seemed to be mostly more swolling, than those corresponding ones of Cd especially during the late period of growth. It was suggested that Pb seemed to be have a regulators effects on the prossess 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.

8- 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. Sugar beet root system seemed to be relatively more sensitive to the phytotoxification of the pollutant elements than the shoot one. The reduction effects of Cd or Pb 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.

9- 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 organ, inspite of the continuos increase of shoot system growth in the terms of whole plant leaf area , fresh and dry weights of leaves.

10-There are some limiting variations in the distribution of dry matter in root 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.

11-With regard to the effects of the toxic heavy metals on different tested ratios, it may be concluded that limiting changes were obtaind 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.

12- 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.

13-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.

14- Both heavy metals affected the ratio of root weight RDW/RFW, i.e. affected the ratio of water balance 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.

15-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.

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

17-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.

18-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.

19-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.

20-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.

21-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.

22-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 .

23- 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 .

24-With regard to the combined effects of different Cd or Pb rates with variable GA_3, NAA and B_9 levels decreased the harmful effect of the used heavy metals on photosynthetic pigments concentration. Plastid pigments have been shown as one of the main sites of the toxic Cd action .

25- 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.

26- 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.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.

27- 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

28-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.

29-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.

It could be recommended to use GA_3 to minimize the harmful effects of Cd or Pb on plant growth and its productivity of sugar beet plant.

It was suitable to carry out more studies in this respect, if the question is to be fully uncured.