CHAPTER VI

SUMMARY
Summary:

Environmental contamination is a major problem being faced by the society. One of the many pollutants in the environment is heavy metals. The presence of heavy metals in environment is due to a natural and an anthropogenic origin. Heavy metals are among the most toxic pollutants present in marine, groundwater and industrial wastewater. The source of heavy metals in environment, and more specifically in water systems has been attributed primarily to man made sources, such as agricultural activities and stack emissions from industrial sources. While the toxic metal compounds turned back to earth arrive to surface waters with river, rain and snow waters, they may be mixed to groundwater by filtering from soil. However, natural waters also contain toxic metals depending upon the structure of bedrock.

The most activities have concentrated some of heavy metals in certain areas up to the dangerous levels of living organism. Heavy metals such as lead, mercury, arsenic, copper, zinc and cadmium are toxic for the plants and humans even at very low level of intake and accumulated in living organisms and produce disease and disorders. The toxic metals can be taken up directly by humans and animals through the inhalation of dusty soil or they may enter the food chain as a result of their uptake by edible plants and animals or leach down to groundwater and contaminate drinking water resources, and may cause, in both cases, hazards to the health of humans and animals.

Metals play an integral role in the life processes of living organisms. Some metals, such as calcium, cobalt, chromium, copper, iron, potassium, magnesium, manganese, sodium, nickel, zinc, are essential nutrients, while others have no biological role, e.g. silver, aluminium, cadmium, gold, lead, and mercury. Essential metals are catalysts in biochemical reactions, function as stabilizers of
protein structures and bacterial cell walls, and serve in maintaining osmotic balance. High concentrations of most metals, regardless of being essential or non-essential, are toxic for living cells, cadmium being among the most toxic ones. Plants take up metal trace elements from the soil through the root. Some of the trace elements are essential as plant nutrients, but plants growing in a polluted environment can accumulate metals at high concentrations, causing a serious risk to human health when the plant enters the food chain. It is known, that high concentrations of metals in plants can interfere with physiologically important functions of the plants, can cause imbalance of nutrients and have detrimental effects on synthesis and functioning of biologically important compounds, such as enzymes, vitamins, hormones, etc.

Knowledge on the contamination with heavy metals from different areas is not well established. The process of metal uptake and accumulation by different vegetable plants depend on the translocation in plants from sites of deposition in natural field receiving industrial discharges. Therefore a study was initiated on this aspect in order to avoid possible adverse effects on human health. In the present investigation, an attempt has been made to study the accumulation and distribution pattern of Fe, Cu, Zn, Co, Cr, Cd, Ni, Pb and Mn contents in different parts of vegetable crop plants species grown contaminated agricultural fields near Gajulamandyam industrial area, Chittoor district, Andhra Pradesh, India, large number of industries are located in the adjacent area. Most of the industries discharge their untreated waste effluent into a natural drain. And also to study of phytotoxicological affects of cadmium on *Arachis hypogea* L. two varieties (KADIRI and TCGS 320).

- Present study water quality parameters such as pH, EC, dissolved solids, total solids, dissolved oxygen, BOD, COD were found high level concentrations. The concentrations of heavy metals such as Fe - 448 mg/l,
Mn - 13.7 mg/lt, Zn - 4.61 mg/lt, Cu - 3.65 mg/lt, Cr - 0.94 mg/lt, Cd - 1.08 mg/lt, Pb - 0.91 mg/lt, Ni - 0.88 mg/lt and Co - 0.18 mg/lt. were observed in the industrial discharges in the study area.

- The concentration ranges of heavy metals were Fe 382.12 mg/l, Cu 5.57 mg/l, Zn 9.26 mg/l, Co 1.22 mg/l, Cr 1.42 mg/l, Cd 1.51 mg/l, Ni 1.07 mg/l, Pb 1.15 mg/l and Mn 17.91 mg/l. were found high level metal concentration in the irrigated water samples in study area.

- The concentrations of Fe 314.13 mg/kg, Zn 9.85 mg/kg, Co 2.30 mg/kg, Cr 1.82 mg/kg, Cd 1.81 mg/kg, Ni 1.29 mg/kg, Cu 4.48 mg/kg, Pb 1.24 mg/kg and Mn 25.73 mg/kg were observed in contaminated soils.

- BAF value of heavy metal in the edible part, which is an index for evaluating the transfer potential of heavy metal from soil to the edible part, represents the potential risk to human health. The BAF values of Fe on the basis of dry weight were 1.46 mg/kg in Saccharum officinarum (leaves), 1.28 mg/kg in Moringa oleifera (twigs), 1.26 mg/kg in Hibiscus esculentus (twigs) and 1.25 mg/kg Hibiscus cannabinus (root) cultivars respectively.

- The highest Cu BAF value was found 4.69 mg/kg in Hibiscus cannabinus (twigs), 3.79 mg/kg in Sesbania grandiflora (twigs) and 3.17 mg/kg in Hibiscus cannabinus (leaves) cultivars. The highest Zn BAF (9.47 mg/kg) values were observed in Saccharum officinarum (leaves). Co BAF (1.05 mg/kg) values were higher in Hibiscus cannabinus (twigs) cultivars respectively. The BAF values of Cr were 2.80 mg/kg in Hibiscus cannabinus (root) and 1.94 mg/kg in Hibiscus esculentus (twigs) cultivars respectively. The highest Cd BAF value was found 2.77 mg/kg in Hibiscus esculentusL (twigs), 2.24 mg/kg in Saccharum officinarum...
(leaves) and 2.14 mg/kg Arachis hypogaea (root) cultivars. The BAF values of Ni were 3.49 mg/kg in Sesbania grandiflora (twigs) and 2.95 mg/kg in Hibiscus esculentus (twigs) cultivars respectively. The highest Pb BAF values was found 3.51 mg/kg in Hibiscus cannabinus (root), 3.25 mg/kg in Sesbania grandiflora (twigs) and 3.11 mg/kg in Sesbania grandiflora (leaves). The highest Mn BAF values were found 2.66 mg/kg, 2.04 in Oryza sativa (root and leaves) cultivars respectively.

The investigation is taken up to study the possible impact of lower cadmium on some biochemical aspects of selected crop plants. Cadmium is not an essential mineral nutrient for plants, it is easily absorbed by the root system. Cadmium is a widespread pollutant with a long biological half life and enters food chain resulting in a serious health issue for humans.

The seeds were initially treated with three different concentrations CdCl₂ solutions 0 (control), 25, 50, 100 μM in separate pots, till the maximum growth of the crop was observed and observations were made after 10, 15, 20, 25 days of treatment. The crop plants chosen for experimentation are Arachis hypogaea L var Kadiri and TCGS 320.

Seeds naturally require water before germination. The impact of Cd concentrations (0, 25, 50, 100 μM) on seed germination is studied in Arachis hypogaea L var Kadiri and TCGS 320. The statistical data shows that in the both Arachis hypogaea L var Kadiri and TCGS 320 seeds there is a significant effect of Cd treatment on germination percentage.

In the present study the root length and shoot length also decreased due to higher concentrations of cadmium solutions. The statistical data shows
that the effect of cadmium treatment on shoot length or root length is highly significant in Arachis hypogaea L var Kadiri and TCGS 320.

- *Arachis hypogaea* L var Kadiri and TCGS 320 seedlings grown over a period of 10-25 days, total chlorophyll including chlorophyll a, and chlorophyll b decreased from 10th to 25th day and with increased Cd concentrations (25, 50, 100 µM). In the present study, major change was observed in *Arachis hypogaea* L var Kadiri at 25 µM, 50µM and 100µM cadmium treatment.

- Protein in *Arachis hypogaea* var Kadiri and TCGS 320 leaf and root showed decreasing trend with increasing cadmium concentrations (0, 25, 50, and 100 µM) and between 10 - 25 days after showing. Our studies reveal that Cd toxicity is more in root than in leaf were observed in *Arachis hypogaea* var Kadiri and TCGS 320 leaf and root. The percentage changes are more both in roots and leaves at 100µM Cd concentrations on 25th day in *Arachis hypogaea* var Kadiri.

- Starch in *Arachis hypogaea* var Kadiri and TCGS 320 leaf and root showed decreasing trend with increasing cadmium concentrations (0, 25, 50, and 100 µM) and between 10 - 25 days after showing. The decrease in starch is more pronounced in root than in leaves which may be due to degradation of starch. In the present study, major change was observed in *Arachis hypogaea* L var Kadiri at 25 µM, 50µM and 100µM cadmium treatment.

- The total carbohydrates also decreased in higher concentrations of cadmium. The decreased in total carbohydrates levels in cadmium treated plants may be due to reduced rate of photochemical activities and the pigment composition, which are required for CO₂ assimilation and
carbohydrate formation. The major change was observed in *Arachis hypogaea* L var Kadiri at 25 μM, 50μM and 100μM cadmium treatment.

The two important enzymes involved in nitrate assimilation are nitrate reductase and nitrite reductase enzymes. Nitrate reductase and Nitrite reductase enzyme activity in *Arachis hypogaea* var Kadiri and TCGS 320 leaf and root showed decreasing trend with increasing cadmium concentrations (0, 25, 50, and 100 μM) and between 10 - 25 days after showing. Present studies reveal that Cd toxicity is more in root than in leaf were observed in *Arachis hypogaea* var Kadiri and TCGS 320 leaf and root. The percentage changes are more both in roots and leaves at 100μM Cd concentrations on 25th day in *Arachis hypogaea* var Kadiri.

The total free amino acid in *Arachis hypogaea* var Kadiri and TCGS 320 leaf and root showed decreasing with increasing cadmium concentrations and the proline in *Arachis hypogaea* var Kadiri and TCGS 320 leaf and root showed increasing with increasing cadmium concentrations (0, 25, 50, and 100 μM) and between 10 - 25 days after showing.

Antioxidant enzymes and certain metabolites play an important role in adaptation and ultimate survival of plants during periods of stress. Infact, activities of antioxidative enzymes are inducible by oxidative stress, which reflects a general strategy required to overcome stress.

As cadmium application increased from 25, 50, 100 μM, the SOD, POD, CAT antioxidant enzymes activities in leaves and root showed increasing between 10th - 25th day were observed.
The major objective of the above investigation is to study the possible accumulation and distribution of heavy metals in water samples, soil samples and vegetable crop plants. These results suggest that a low level concentration of cadmium (25, 50, and 100 μM) induces physiological, biochemical changes in plants. The activity of antioxidative enzymes could serve as important components of antioxidative defense mechanism against oxidative injury.