V. SUMMARY AND CONCLUSION
SUMMARY AND CONCLUSION

The proposed study "Impact of heavy metals on some medicinal plants" dealt with the effect of three micronutrient heavy metals (Zn, Cu, Cr) on three medicinal plants of Asteraceae namely Emilia sonchifolia DC., Eclipta alba Hassk. and Spilanthes acmella Murr. The different concentrations of the heavy metals were used to treat the germinating seeds there by their influence on germination, seedling growth, chlorophyll and carotenoids, protein and carbohydrate content, stomatal characters (stomatal index and stomatal frequency), palisade ratio, morphological characters (height of plant, length of root, number of leaves, number of branches etc.), yield, productivity and the seeds could be studied extensively. Accumulation of heavy metals on different plant parts was well traced in the concluding part of the work.
The heavy metal treated seeds showed maximum germination and seedling growth in Zn treatment followed by Cu and Cr. The toxicity of Zn, Cu and Cr changed with the plants. In Spilanthes acmella Murr., Cu caused more destructive effects than Cr. The fatal results of heavy metal treatments in Emilia sonchifolia DC. were in the order Zn <Cu <Cr. The 100ppm of the heavy metal produced maximum disastrous effect and at optimum concentrations (10ppm Zn, 1 ppm and 10ppm Cu and 1ppm Cr) the most favourable results were noticed.

The treatments led to reduced chlorophyll and carotenoid contents. The degree of reduction varied with concentration and plants. In lower concentrations (10ppm Zn, 1ppm and 10ppm Cu and 1ppm Cr) the heavy metals showed a provoking effect on chlorophyll and carotenoid contents. But at 100 ppm heavy metal concentration the plants showed a deleterious effect.

The reduction in biochemical contents of the plants at the elevated level of heavy metals reflects their toxicity. Augmented results in the lower concentrations unveil the micronutrient nature of the heavy metals.

Histochemical study (starch, polysaccharides, lipids, proteins and polyphenols) of the treated plants showed a detrimental effect at 100 ppm level. The lower concentrations of heavy metals were with a determinate results in the histochemical analysis. Polyphenols showed no change with increasing concentrations even in 100ppm (Zn) level. The response of polyphenols varied with plants and heavy metals.

The stomatal characters also varied with plants and heavy metal concentrations. Most striking changes were noted with Cu and Cr
and that too in 100ppm. The palisade ratio also followed the same pattern with no change at lower concentrations and reduced values registered at the 100 ppm treatments.

In all the three plants the morphological characters showed an incited effect at lower concentrations. In higher concentrations, (100ppm) the plants displayed a retarded performance with reduction in the height of plant, length of root, number of leaves and number of branches. Yield and productivity were also found to be decreasing with increased concentrations. All the plants (Emilia sonchifolia DC., Eclipta alba Hassk. and Spilanthes acmella Murr.) were found to exhibit the same result.

The seeds produced showed variation in number and size as a result of the treatment with 100ppm concentration of heavy metals. In Emilia sonchifolia DC. at 100ppm level of Cu and Cr, the seeds produced were sickle shaped. In Spilanthes acmella Murr. and Eclipta alba Hassk. no shape difference was noticed but a reduction in number was recorded. The results explain the resistant nature of seed coat.

The uptake and accumulation of heavy metals varied with plant parts. As per the present result, root accumulates more heavy metals than leaves and stem. The accumulation of heavy metals followed an order Zn>Cr>Cu.

From the results of the present study it can be deduced that at lower concentrations the heavy metals act as micronutrients
stimulating the plant growth, while at higher concentration (100ppm) the same heavy metals induce toxic results. But the extent of heavy metal toxicity varies with plants and their different concentrations.

The plants selected for the phytotoxic study were of the category 'traditional home-stead medicinal plants'. They have a weed nature, occurred widely and used as a folklore medicine. The present investigation was an attempt to analyse the extent of the heavy metal pollution in the selected medicinal plants of Asteraceae. The plants when grown in the vicinities of industrial areas, have a chance to get polluted considerably with the heavy metals (Zn, Cu, Cr).

From the present study it can be concluded that the germination, seedling growth, amount of metabolic products (chlorophyll, carbohydrates and proteins), plant growth, yield, productivity etc. were negatively affected at the higher heavy metal concentration (100ppm). From the studies conducted by Zheljazhov and Nikolov (1995) and Zheljazhov and Nielsen (1996) with heavy metals and medicinal plants reached to the fact that the heavy metals will not contaminate their biochemical content and medicinal property. But once they enter the food chain, gradually will result in the biomagnification with severe uncontrolled outbursts. The heavy metals are found to cause the genotoxic effects and retranslocation of nutrients in plants. Heavy metal pollution leads to ecological imbalances, reduced microbial growth and their activities etc. The impact can be minimised by liming and allowing the interaction with respective ions. Phytoremediation is a method of wide acceptance in which, the heavy metals are absorbed by certain plants such as Brassica species, floating aquatic macrophytes and
various plant materials. Cement Kiln dust is also found to have heavy metal absorbing capacity. Melanophore indexing can be used as a bioassay for the analysis of acute heavy metal toxicity. Heavy metal detoxification in higher plants can be explained with the phytochelatin synthesis, and can be an interesting target for biotechnological modification of heavy metal tolerance in higher plants. Toxicity of heavy metals released into the environment has recently triggered number of studies aiming at the removal of metal ions from aqueous solutions. Removal of metal ions and radionucleides from industrial waste water by microbial biomass is a potential alternative to existing technologies such as precipitation and reverse osmosis. Thus, it can be suggested that the environmental pollution can be detected at an early stage using the index plants, and can be controlled to a certain extent.