Chapter 6 Summary and Conclusion

In conclusion, the toxic effect of Copper (Cu) and Cadmium (Cd) is evident from curtailed growth and reduced biomass. Since both are toxic elements on over dose, the treated seedlings show significant changes in the root length fresh weight and dry weight. Roots are the first site of exposure and toxicity to the metal and thus root length was more severely affected. More growth inhibition, MDA levels, H$_2$O$_2$ accumulation and decrease chlorophyll content were observed in the metal treated seedlings than in the control. The results evidently indicate that the upper limit of Cadmium (Cd) tolerance in Brassica plants is 100 µM and in Soybean plants 200 µM, concentrations higher than this cause cellular toxicity which leads to cell death. Copper (Cu) has been found to be more toxic as it upper limit of tolerance in Brassica plants is 75 µM and soybean plants is 150 µM. Results suggest that the inhibition of photosynthesis and altered electron transport by these toxic metals promotes oxygen free radical production. It is possible that, under stress of heavy metals, plants can evolve a mechanism to complete their life cycles via the ecological adaptive strategy. It suggests that plant cells possess a well organized antioxidative defense system, which operates with the sequential and contemporaneous action of antioxidative enzymes and metabolites. Acute concentrations of these heavy metals may adversely affect the activity of certain defense enzymes either by inhibiting their synthesis or by their inactivation and down regulation. But all these enzymes works in coordinated manner, if some are down regulated at a time, other enzymes are up regulated.

Our data demonstrates that as a consequence of the high stress elicited by Cd and Cu, an up regulation of HO1 gene expression occurred in Brassica juncea (L.) Czern. and Glycine max (L.) Merr. roots and leaves were found after 72 h of exposure. HO1 level has also been increased in callus in a dose dependent manner after 15 days exposure to Cu and Cd metal. Highest expression of HO1 was found in roots in comparison to leaves and callus. This behaviour could explain the major viability observed in roots and also demonstrate that HO1 shows a similar response to a classical heme protein involved in the antioxidant defense system in plant tissues. Findings here reported showed that an inducible HO plays a key role in the enzymatic antioxidant defense system in higher plants. Taken together, the present
results allowed us to conclude that under metal stress HOI gene expression, protein amount and activity are enhanced in an attempt to protect leaves tissues against it. Nevertheless, when the increase in \( \text{H}_2\text{O}_2 \) and \( \text{O}_2^- \) formation overwhelms the defense capacity of the cell, HOI gene is down regulated as it occurs with SOD and CAT. Inhibition of HO-I activity demonstrated that this enzyme plays a leading role in the defense mechanism against metal stress, and it could be considered as essential component of enzymatic antioxidant defense system in plant tissues.

The present study has demonstrated that the newly identified HOI from \textit{Brassica juncea} is differentially expressed at various tissues of the plant. Expression of \textit{BjHOI} can be induced by metal exposure. Functional identification of \textit{BjHOI} reveals that expression of \textit{BjHOI} leads to strengthen the defense system in plants. Because of the low level of metal, the growth status and antioxidant capacity were greatly improved. This indicates that expression of \textit{BjHOI} would be beneficial for the crop growth and production (e.g. rice, wheat and cereal crops), because it is important to limit the uptake or accumulation of heavy metals into eatable part of crops. In nut shell, study focuses on new enzyme HO, which has vital role in plant defense and metabolism and hence the outcome of work directly utilize to produce more tolerant legume and non-legume crops, to develop hyper-accumulators and to understand defense strategies opt by plant during the metal induced oxidative stress as both crops are having major food and economic importance globally.