PREFACE

Plants have developed a very potential mechanism to combat with adverse environmental heavy metal toxicity problems. Therefore understanding the adaptations that occur in plants for survival and performance is of great importance for developing cultivars that can withstand the unsolicited environmental changes. Agricultural soils in many parts of the world are slightly to moderately contaminated by heavy metal toxicity. This is generally attributed to long-term use of phosphatic fertilizers, copper based pesticides, sewage sludge application, industrial waste and bad watering practices in agricultural lands. The chief response of plants is the generation of reactive oxygen species (ROS) upon exposure to high levels of heavy metals. Excess ROS formed within cells can incite oxidation and alterations of cellular amino acids, proteins, membrane lipids and DNA. These changes lead to oxidative injuries and result in the reduction of plant growth and development.

Despite their destructive activity, ROS are useful second messengers in a variety of metabolic processes in the cell that includes tolerance to environmental stresses. The delicate equilibrium between ROS generation and scavenging decides the final function of ROS either as damaging or signalling molecule. It is therefore necessary for the cells to control the level of ROS very securely in order to avoid any oxidative injury and also to be cautious as not to eliminate them completely. Detoxification of excess ROS in the plant is achieved by an efficient antioxidative system that comprises of the nonenzymicas well as enzymic antioxidants. Various authors have reported the alterations of the components of the antioxidative defence system in response to excess metal stress.

A number of heavy metals such as copper, zinc, iron, manganese, nickel etc. are fundamentally essential micronutrients and are required for normal growth and are involved in redox reactions, electron transfers and other important metabolic processes in plants. But these metals can be toxic and cause severe damage to the plant if present beyond threshold levels. Plants show relative differences in their capacity to tolerate heavy metals. Most plants are unable to tolerate high concentrations of heavy metals in the soil while others grow well in soil enriched with toxic levels of heavy metals. At present, research on underlying mechanisms of stress tolerance mainly manifests in herbaceous plants such as the model plant *Arabidopsis* or the cereal food crops such as rice, wheat, maize etc. However, woody plants are different from herbaceous plants in many respects, including growth, development, physiology, morphology and so on. Moreover, tolerance mechanisms of woody and herbaceous plants are different. In the plants, metals are generally translocated via apoplastic pathway and immobilized in the cell walls. Some plants transport the metals to aging organs and leaves and get rid of the metal during seasonal fall. As toxic metals can be a threat when they reach the cell, the ability of the roots to direct the mobilization of the excess metal decides the tolerance capacity of the plant.

The tea plant is a woody perennial with a life span of more than 60 years. Fungal disease is very common and is a major cause of low productivity of tea. Besides, the plant experiences several abiotic stresses of which copper stress is unavoidable as it is the primary component of a number of fungicide. There is therefore an urgent need of comprehensive scientific study of copper stress responses of this important cash crop especially for the identification, selection and/or production of copper tolerant cultivars. The research work compiled in this thesis entitled "Studies on copper toxicity on cultivated varieties of tea of north east India" was commenced in early 2007 with the main objective of investigating the effect of copper on tea plants in the form of morphological and physiobiochemical changes in different tea cultivars. Additionally, the enzymes involved in protecting plants from stress condition have been studied. The extent of copper accumulation in roots and leaves and cytochemical localization of copper in root cells have been investigated. The current thesis initiates with an introduction to the subject of study and a selective literature survey of the past twenty years in two different chapters. The experimental procedure, results and the inferences obtained from the present study is represented in four major chapters and the additional supplementary materials are provided in the appendices at the end of the thesis.