Chapter: 1

INTRODUCTION
Water is a fundamentally important component of the metabolism of all living organisms. As a universal solvent, it facilitates many vital biological reactions in the living system (Bohnert et al., 1995). One of the major consequences of reduced availability is the loss of protoplasmic water leading to increase in the concentration of ions such as Cl\(^-\) and NO\(_3^-\). At high concentrations, these ions effectively inhibit metabolic functions (Hartung et al., 1998). Increase in concentration of protoplasmic constituents and loss of water from the cells leads to the formation of "glassy state" in which the cytoplasmic water attains very high viscosity, thereby increasing the chances of molecular interactions that can cause protein denaturation and membrane fusion (Hartung et al., 1998; Hoekstra et al., 2001).

Salinity is one of the major abiotic stresses affecting plant growth and productivity globally. Modern-day plants are products of eons of evolution from primal living organisms in response to abiotic and biotic environmental changes.
Water is one of the major abiotic factors that has shaped evolution of living organisms. Water stress, in its broadest sense, encompasses both drought and salt stress. Drought, salt stress and low temperature are the major problems for agriculture because these adverse environmental factors prevent plants from realizing their full genetic potential. Salt stress afflicts plant agriculture in many parts of the world (Epstein et al., 1980). Compared to salt stress, the problem of drought is even more pervasive and economically damaging (Boyer, 1982). Nevertheless, most studies on water stress signaling have focused on salt stress primarily because plant responses to salt and drought are closely related and the mechanisms overlap.

Since the response of plants to drought is complex and diverse (Alpert and Oliver, 2002; Levitt, 1980; Walters et al., 2002), the need for an understanding of the physiological response of plants under water-limited conditions is of critical importance. Plants can perceive abiotic stresses at the molecular and cellular levels as well as at the physiological and biochemical levels, and elicit appropriate responses with altered metabolism, growth and development. Salt stress is known to induced the expression of a wide array of genes (Ingram and Bartels, 1996; Shinozaki and Yamaguchi-Shinozaki, 2000; Thomashow, 1999). The products of these genes function not only in stress tolerance but also in the regulation of gene expression and signal transduction in stress responses (Bartels and Sunkar, 2005; Shinozaki and Yamaguchi-Shinozaki, 2000; Xiong et al., 2002). This cascade of events acts through second messengers leads to physiological responses that are exhibited by plants under stress (Trewavas et al., 1997). The signal transduction pathways can
operate independent of each other or may also share components and second
messengers (Knight and Knight, 2001). A common aspect of most adverse
environmental conditions is the increased production of reactive oxygen species
(ROS) within several subcellular compartments of the plant cell (Van Breusegem et
al., 2001). While ROS levels can change during cellular metabolic events such as
photosynthesis, their formation is usually exacerbated during stressful environmental
conditions.

Salt and drought stresses affect virtually every aspect of plant physiology and
metabolism. Plants responses to salt and drought stress can be grouped into three
categories: (a) homeostasis that includes ion homeostasis, which is mainly relevant
to salt stress, and osmotic homeostasis or osmotic adjustment; (b) stress damage
control and repair, or detoxification; and (c) growth control (Zhu, 2001).
Accordingly, salt and drought stress signaling can be divided into three functional
categories: (a) ionic and osmotic stress signaling for the re-establishment of cellular
homeostasis under stress conditions, (b) detoxification signaling to control and repair
stress damages, and (c) signaling to coordinate cell division and expansion to levels
suitable for the particular stress conditions. Current evidence supports the concept
that ROS represent a significant point of convergence between pathways that respond
to biotic and abiotic stresses. To date, the biological significance of crosstalk
between signaling pathways that operate under stress conditions and the mechanisms
that underlie this crosstalk remain obscure. Nevertheless, our current understanding
of ROS participation in crosstalk between these pathways is very limited. Thus,
dissection of the networks that influence ROS levels in response to abiotic stress merits extensive future study. The present work was undertaken to investigate the role of calcium ions and abscisic acid in modulating detoxification systems during early stages of salt stress in maize.