Chapter - 1

Introduction
INTRODUCTION

Aluminium is the most abundant metal and third most common metal in the earth’s crust, constituting about 8% of total soil minerals. At neutral and alkaline pH aluminium occurs in combined form as oxides or even more commonly as aluminosilicates, which are non toxic to plants. However, at low pH (below pH 5) the solubility of aluminium compounds is generally increased (Jones and Ryan, 2003). Soluble aluminium cation (Al\(^{3+}\)) in acid soils is phytotoxic and thought to be a major limiting factor for plant growth and productivity on these soils (Kochian et al., 2004). Thus it is an important factor limiting food production in many developing countries.

Toxic effects of Al on plant growth have been attributed to several physiological and biochemical pathways (Roy et al., 1988). Al toxicity causes disruption of many important activities in plants, including inhibition of cell division, disjunction of cell wall, inhibition of ion fluxes, disruption of plasma membrane integrity, failure in Ca homeostasis, inhibition of signal transduction pathway and alteration in cytoskeleton structure (Matsumoto, 2000; Rout et al., 2001). Root apex is the primary site of Al induced root growth inhibition (Rengel, 1996; Ma et al., 2004). Aluminium can interact with a number of extracellular and intracellular substances like interaction with the root cell walls, disruption of plasma membrane and symplastic constituents such as calmodulin (Kochian, 1995). Plants grown in acid soils due to solubility of Al at low pH have undeveloped root system and exhibit a variety of nutrient deficiency symptoms, consequently led to decrease in yield of crop. Al also
interferes with uptake, transport and utilization of essential nutrient including Ca, Mg, K, P, Cu, Fe, Mn and Zn (Guo et al., 2003).

Calcium is an essential plant nutrient required for structural role in cell walls and membranes and act as counter cation for inorganic and organic anions in vacuole and intracellular messenger in the cytosol (Marschner, 1995). Moreover, cytosolic Ca\(^{2+}\) also acts as intracellular messenger coordinating responses to numerous developmental cues and environmental challenges (Marschner, 1995; White and Broadley, 2003). Calcium in addition to its role in cross linking the pectic material in cell wall also plays an essential role by acting as a secondary messenger in regulating plant functions from nutrient uptake to changes in cell status and also against abiotic and biotic stresses (Sanders et al., 2002). Calcium also plays a role similar to plant hormones in the regulation of various cell functions in the plant. Moreover, it has also been reported that Ca helped to increase metal resistance by reducing the toxic effects of heavy metal in crop plants (Horst, 1987; Gabbrielli et al., 1995).

Brassinosteroids (BRs) are a new class of steroidal plant hormone, ubiquitously distributed in plant kingdom. Structurally related to animal and insect steroid hormones, the brassinosteroids generally occur in all parts of the plants including roots (Bajguz and Tretyn, 2003). This hormone evoke a wide range of physiological responses in plants, including stem elongation, pollen tube growth, leaf bending and epinasty, induced synthesis of ethylene, activation of proton pump, xylem differentiation, synthesis of nucleic acid and proteins, activation of enzymes and photosynthesis (Clouse and Sasse, 1998;
Khripach et al., 2003; Bajguz and Hayat, 2009). Till now, 65 unconjugated brassinosteroids and 5 sugar fatty acids conjugate have been detected in the plant kingdom (Bajguz and Tretyn, 2003). However, brasisnolide, 24-epibrasisnolide and 28-homobrasisnolide are the three bioactive brassinosteroids being widely used in physiological studied (Khripach et al., 2000). Recently, ameliorative roles of BRs have been recognized in plants subjected to various biotic and abiotic stresses (Clouse and Sasse, 1998; Hayat et al., 2009). The exogenous application of BRs increased tolerance to low and/or high temperature stress, drought stress and moisture stress. Similarly, the BR treatment countered the stress imposed by NaCl (Clouse and Sasse, 1998; Sasse, 2003) and heavy metal stress, i.e. cadmium (Hasan et al., 2008), nickel (Alam et al., 2007) and copper (Fariduddin et al., 2009a).

Keeping in mind the ameliorative role of brassinosteroids in various stresses the present piece of work was designed with an aim to evaluate the changes in antioxidant system and other metabolic markers under the influence of 24-epibrassinolide and calcium in Cucumis sativus exposed to aluminium and to establish a relationship between the changes in antioxidant system and the degree of resistance in terms of improvement in growth and photosynthesis.