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Role of Micronutrients in Biotic and Abiotic Stress Management in Plants

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Abstract

Biotic and abiotic stresses constrain the crop productivity and are of great scientific concern Micronutrients, serving as the components of many vital enzymes play an important role in various physiological and biochemical pathways in plants. In addition, micronutrients are required for a wide range of biological functions like photosynthesis, chlorophyll synthesis, respiration, nitrogen fixation, nutrient uptake mechanisms and DNA synthesis etc. Micronutrients have been mainly recognized as essential elements for plant growth. In addition, these also play an irreplaceable role in alleviating stress imposed by biotic and abiotic factors. Micronutrients activate number of antioxidants in plants which serve as scavengers for reactive oxygen species (ROS). This review elucidates the role of micronutrients in biotic and abiotic stress management and tolerance strategies in crops.

Key words: Abiotic stress, biotic stress, disease, management, micronutrients

Introduction

Stress is defined as an event that restricts crop productivity or destroys biomass. In the current climate change scenarios, crops are exposed more frequently to episodes of biotic and abiotic stresses such as drought, salinity, elevated temperature, submergence, nutrient deficiencies and pest-diseases infestation etc. These stresses can persistently limit choice of crops and agricultural production over large areas and extreme events can even lead to total crop failures. In recent years, advances in physiology, molecular biology and genetics have greatly improved our understanding of crops response to these stresses and the basis of varietal differences in tolerance. Management of abiotic stress is one of the most difficult challenges facing agriculture. Abiotic stress is a consequence of several environmental disturbances caused by the continuous encroachment of urbanization, industrialization, and some human interferences with the natural ecosystem that influence the quality and quantity of agriculture production every year (Mantri et al., 2012). Abiotic stresses comprise potentially negative effects of drought, salinity, metal toxicity and extreme temperature etc. (Singh et al., 2015). Various techniques are being used to protect plants from the adverse effects of stresses which include varietal modification, advanced disease–pest management techniques, exogenous supplementations of beneficial elements, growth-promoting hormones, enzymes, and nutrient management. Among the remedies for biotic and abiotic stress, nutrient regulations or management are considered as the cost-effective and eco-friendly techniques (Tripathi et al., 2015; Yadav et al., 2016). Nazar et al. (2012) reported the significant positive result of calcium (Ca), magnesium (Mg), sulphur (S), zinc (Zn), and iron (Fe) under salinity, drought, and metal stresses. Currently, the importance of micronutrients to impart the tolerance to plants against stresses as an emerging field of research is gaining attention. Therefore, adequate application of micronutrients is essential and pre-requisite for sustaining plant productivity under stress as well as non-stress conditions.

The term 'micronutrients' represents essential nutrients that are required in small quantities for the normal growth and development of plants. These include zinc (Zn), copper (Cu), iron (Fe), manganese (Mn), nickel (Ni), boron (B), molybdenum (Mo) and chlorine (Cl). In India, origin of micronutrient management research is traced back to a publication by Iyer et al. 1934. Real impetus on micronutrient research came with report of *khaira* disease in mid-sixties (Nene, 1965) and establishment of All India Coordinated Research Scheme on Micronutrients in Soils and Plants in India. Cakmak (2005) opined that micronutrient-dense seeds improve tolerance to abiotic stresses and give higher yields on micronutrient deficient soils. Thus micronutrients are not only important for better crop productivity but also exogenous supply of micronutrients plays a crucial role in the enhancement of plant tolerance against various biotic and abiotic stresses (drought, salt stress, disease, high temperature, and insect stress etc.) on plants.

Abiotic Stress Management

Drought Stress

Among the environmental stress factors, drought stress is one of the most widely limiting factor for crop production on a global basis. It harms plant growth and development and reduces the growth rates of crop and biomass accumulation. Generally, in crop plants, drought severely affects cell division and expansion, elongation of root, leaf size,

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