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Editorial

Micronutrients Induced Alteration of Antioxidant Enzymes in Plants

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Editorial

Trace elements are being considered as vital nutrients for plants as they sharply regulate the growth, development and various metabolic processes. As their requirements are in very minute quantities for optimal operation of cellular activities, hence popularly known micronutrients. These elements comprise of vanadium to zinc in the first row series of the periodic table as well as molybdenum in the second row series whose entry into the plant systems depend upon either reduction/ oxidation or both. Among all trace elements, some are obligatory for life and also the primary cause of toxicity when present in excess amount. The physiological and molecular essentiality of these elements depends upon the availability of micronutrients which further decide the deficiency, sufficiency, and toxicity by performing certain metal-based homeostasis to overcome the situation [1,2].

In other hands, the over bioaccumulation of such micronutrients led to generate the highly Reactive Oxygen Species (ROS) such as superoxide anion radical ($O_2^{\bullet-}$), Hydrogen Peroxide (H_2O_2), Singlet Oxygen ($^1O_2$), and hydroxyl radicals ($OH^{\bullet}$) which are majorly synthesized in mitochondria, chloroplast, peroxisome, endoplasmic reticulum and apoplast of a plant cell [3,4]. Under high deposition of free radicals and radical-derived nonradical reactive species, the cells are facing a hazardous atmosphere by damaging cellular lipids, proteins, carbohydrates and nucleic acids, inhibiting their normal cellular function and ultimately arrest the whole cellular activities [5]. At that time metal ions play a crucial role by serving as the cofactor of various antioxidant enzymes to neutralize the oxidative stress situation within the cell with different tolerant strategies development.

Plants tolerate stress by producing various antioxidative enzymes, which act against ROS. Several ROS are continuously produced by the plant as by-products of various metabolic processes. Under physiological steady state condition, these molecules are scavenged by different antioxidative defense compounds. But in nutritional stress conditions (either less/ excess), there is a rapid increase in ROS which is known as an oxidative burst. Plants possess several antioxidant defense systems, comprised of enzymatic and non-enzymatic components that normally keep ROS in balance within the cell [1]. For instance, they use a diverse array of enzymes, such as superoxide dismutase (SOD, EC 1.1.5.1.1), catalase (CAT, EC 1.11.1.6), guaiacol peroxidase (GPX, EC 1.11.1.7), and ascorbate peroxidase (APX, EC 1.11.1.11) as well as low molecular mass antioxidants, including ascorbate, tocopherols and reduced glutathione (GSH) to scavenge different types of ROS [6]. SOD is a metalloprotein that catalyzes the dismutation of superoxide to H_2O_2 and molecular oxygen. CAT found predominantly in peroxisomes, dismutates H_2O_2 into H_2O and O_2, whereas, POX decomposes H_2O_2 by oxidation of co-substrates such as phenolic compounds and/ or antioxidants [5,7].

Micronutrients not only required by plants for the growth and development but also metals like Fe, Zn, Cu, Mn, and Mg at their ionic forms act as co-factors for activation of several antioxidant enzymes. Under micronutrient deficiency/ sufficiency the activity of antioxidant enzymes alters its mechanism of action, which in turn act as sensitivity to environmental stresses [8]. In the case of Zn, nearly about 200 numbers of enzymes are dependable to perform the metabolic systems under optimum concentration however, it plays a lead role with the association of Cu to generate the catalytic center for activation of CuZn-SOD otherwise, oxidative damage of proteins, lipids and DNA may start [9]. Similarly, Fe deficiency/ excess has also been reported as an associated factor for the overproduction of ROS as this metal is directly linked for the activation of CAT which converts H_2O_2 into H_2O and O_2. Mn also acts as the raw material for the activation of several enzymes including Mn-SOD which triggers the modulation of superoxide anions [10]. In addition, the antioxidant machinery smoothly regulates their activities by cooperating with each other to inhibit the chain reaction of production of ROS which indicates that the less or elevated concentration of required micronutrients may create an obstacle at any point of the detoxication processes. Further, elemental interaction either by antagonistic or synergistic mechanisms develops to adjust or overcome the metal causing stress situation as required. Therefore, the role micronutrients are always crucial in cell developmental processes due to their multifunctional properties.

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