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Mini Review

Exogenous Application of Exogenous Effectors Confers Tolerance to Heavy Metals in Plants

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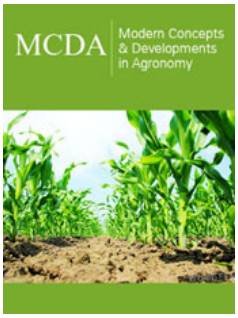

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Abstract

The protective effect of exogenous effectors applications against heavy metal toxicity in plants was investigated in this mini review. The exposure of plants to heavy metals caused high metal accumulation in tissues associated with increased levels of oxidative stress biomarkers as well as enhanced antioxidant enzymes. Hence, exogenous effectors were effective in reducing heavy metals-induced toxicity by maintaining the redox cell status.

Introduction

Plants in their environment are subjected to a variety of stressful factors which generate physiological reactions leading to the formation of free radicals. These factors are divided into two groups: Biotic factors such as pathogens, bacteria and insects and abiotic factors namely salinity, certain growth substances, atmospheric pollutants, cold, UV radiation, heavy metals.

The contamination of soils by heavy metals is one of the most worrying problems today. It does not only concern the degradation of the environment, with its consequences on flora and fauna, but also represents a real public health problem by the threat of contamination of foodstuffs or by insufficient harvests [1-7]. Heavy metals that accumulate in the soil on industrial sites can be assimilated by spontaneous, replanted or cultivated vegetation. Heavy metals induce physiological and biochemical changes in plants. Indeed, several studies have made it possible to understand, in part, the course of certain defense strategies adopted by plants vis-à-vis metallic stress and to highlight biochemical and molecular modifications affecting certain physiological processes such as, lipid metabolism [6], photosynthesis [8], oxidative metabolism [9,10].

High levels of heavy metals in soil as well as in water can cause:

1) Oxidative stress by accelerating the production of reactive oxygen species, high metal accumulation in tissues and lipid peroxidation [4,6], and

2) Damages in homeostasis states of ascorbate–glutathione cycle by increasing antioxidant enzyme activities such as superoxide dismutase (SOD), ferredoxin (Fdx), NADPH-dependent ferredoxin reductase (FNR), thioredoxin (Trx), NADPH-dependent thioredoxin reductase (NTR), glutathione peroxidase (GPX), glutathione reductase (GR) and glutathione-S-transferase (GST) [11,12].

Plants possess various strategies to counteract the negative effects of heavy-metal-induced oxidative stress, including the exclusion of ions, the control of ion uptake and translocation to leaves, as well as the accumulation of compatible solutes (carbohydrates and proline) [13]. Additionally, to cope with oxidative stress plants have developed non-enzymatic defense system including ascorbic acid (AsA), glutathione (GSH), carotenoids and cysteine

as well as enzymatic defense system such as superoxide dismutase (SOD), peroxidase, catalase and the enzymes of the glutathione-ascorbate (GSH-AsA) cycle: ascorbate peroxidase (APX), glutathione reductase (GR), monodehydroascorbate reductase (MDAR) and dehydroascorbate reductase (DHAR) [3].

Several researchers have adopted new strategies to protect plants against abiotic stresses such as the application of exogenous effectors like auxin, gibberellic acid, calcium, citrate, nitric oxide, hydrogen disulfide [10,14-21]. Moreover, some of those exogenous effectors like calcium was shown to be involved in the signal transduction of environmental stimuli and related gene expression in plants, increasing the tolerance of plants against cadmium [15,17] and Cu [20].

Conclusion

The biological activity of heavy metals can be markedly alleviated by the presence of metal chelators which may reverse their toxicity. Investigations indicated that exogenous effectors can reduce heavy metal toxicity by forming complex compounds with them which are then, either eliminated or unable to cross biological membranes.

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