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Physiological responses to zinc excess in Arabidopsis non-extremophile and extremophile plant species : interaction with drought and role of plant defensins

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Abstract

Plants are continuously exposed to several biotic and abiotic stresses. Plant responses to these stresses are highly complex and involve changes at the transcriptome, cellular, as well as physiological levels. Among these stresses, drought is one of the most detrimental factors for plant growth and productivity and is considered a severe threat for sustainable crop production, especially under current changing climate. The aim of this study is to investigate traits and/or mechanisms involved in plants response to water deficit under zinc condition using plant material *A. halleri*. *Arabidopsis halleri* is a hypertolerant and hyperaccumulator plant species for zinc and cadmium; this evolutionary feature represents a valuable potential to investigate plant responses to multiple stresses. Here, we developed a comparative approach using this particular species and two closely related species, *A. thaliana* and *A. lyrata*, both sensitive to zinc excess. We characterized morpho-physiological traits of three Arabidopsis species in response to combinations of water deficit and zinc excess. The findings showed that, *A. halleri* plants has increased tolerance to water deficit compared to *A. thaliana* and *A. lyrata* when grown under high zinc concentration in the soil. *A. halleri* showed higher ability to control leaf water content by reduced water loss through transpiration due to reduction of stomatal conductance which ultimately positively increased water use efficiency. Our study shows that, zinc excess and water deficit have additive negative effects on the growth of *A. thaliana* species plants, whereas *A. lyrata* is less affected by the addition of Zn under conditions of WD compared to WW conditions. The combination of these stresses has a positive interactive effect on the growth of *A. halleri* plants. In other hand, plant defensins (PDF) are involved in plant responses to biotic and abiotic stresses. The purpose of this work was also to understand the contribution of *PDF Type 1 (PDF1s)* in the response of plants to zinc excess using comparatively wild-type *A. thaliana* plants and transgenic amiRNA plants targeting the reduction of transcripts *PDF1s*. We compared the physiological characteristics of mature plants grown in the presence of excess zinc in the soil, and under hydroponic conditions. Our results show that, under the effect of zinc, the decrease in *AtPDF1s* transcripts is associated with a lower zinc tolerance than that observed in wild-type *A. thaliana* plants without a change in zinc content.

Keywords: Arabidopsis, extremophilic plant, PDF1, water deficit, zinc excess.