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Constitutively elevated salicylic acid signals glutathione-mediated nickel tolerance in Thlaspi nickel hyperaccumulators

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Objectives

We have studied relationship between *Thlaspi* gene that confers Ni tolerance and salicylic Acid signaling.

Materials and Methods

1. Material

   Plant-*Thlaspi and Arabidopsis* plants

2. Methods

   To establish a role for SA in Ni/Zn hyperaccumulation, we performed experiments on the related nonaccumulator Arabidopsis and accumulator Thlaspi

Results and Discussion

Progress is being made in understanding the biochemical and molecular basis of nickel (Ni)/zinc (Zn) hyperaccumulation in Thlaspi; however, the molecular signaling pathways that control these mechanisms are not understood. We observed that elevated concentrations of salicylic acid (SA), a molecule known to be involved in signaling induced pathogen defense responses in plants, is a strong predictor of Ni hyperaccumulation in the six diverse Thlaspi species investigated, including the hyperaccumulators Thlaspi goesingense, Thlaspi rosulare, Thlaspi oxyceras, and Thlaspi caerulescens and the nonaccumulators Thlaspi arvense and Thlaspi perfoliatum. Furthermore, the SA metabolites phenylalanine, cinnamic acid, salicyloyl-glucose, and catechol are also elevated in the hyperaccumulator T. goesingense when compared to the nonaccumulators Arabidopsis (Arabidopsis thaliana) and T. arvense. Elevation of free SA levels in Arabidopsis, both genetically and by exogenous feeding, enhances the specific activity of serine acetyltransferase, leading to elevated glutathione and increased Ni resistance. Such SA-mediated Ni resistance in Arabidopsis phenocopies the glutathione-based Ni tolerance previously observed in Thlaspi, suggesting a biochemical linkage between SA and Ni tolerance in this genus. Intriguingly, the hyperaccumulator T. goesingense also shows enhanced sensitivity to the pathogen powdery mildew (Erysiphe cruciferarum) and fails to induce SA biosynthesis after infection. Nickel hyperaccumulation reverses this pathogen hypersensitivity, suggesting that the interaction between pathogen resistance and Ni tolerance and hyperaccumulation may have played a critical role in the metal hyperaccumulation in the Thlaspi genus.

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