Division-2-04

Glutathione-Mediated Modulation of Cadmium Stress Responses in Oilseed Rape Plants: Oxidative Stress, Redox Status, and Hormone Balance

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[Introduction]

The antioxidant glutathione (GSH) alleviates adverse physio-metabolic effects and defends against abiotic stresses including cadmium (Cd) stress. However, its function and role in resisting Cd phytotoxicity by leveraging plant antioxidant-scavenging, redox-regulating, and hormone-balancing systems have not been comprehensively and systematically demonstrated in the Cd-hyperaccumulating plant *Brassica napus* L. cv. Tammi (oilseed rape).

[Materials and Methods]

The hydroponically cultivated *B. napus* seedlings were grown in a greenhouse (National Institute of Agricultural Science, Wanju, Republic of Korea) with natural sunlight, day/night temperatures of 30°C/25°C, and also day/night relative humidity of 60%/80%. Four-leaf seedlings were then grown in hydroponics treated with 10 μM of Cd ($CdCl_2$) and were simultaneously sprayed with GSH (50 and 100 mg kg^{-1}) and 2 ml L^{-1} of commercial surfactant (10% polyoxyethylene alkyl aryl ether and 20% sodium lignosulfonate). Ten days after treatment, fresh samples of roots and leaves were frozen in liquid nitrogen and stored at -80°C until further analyses of the reactive oxygen species (ROS), redox, and hormone levels.

[Results and Discussion]

Cd stress alone significantly inhibited growth and increased the levels of ROS and the bioaccumulation of Cd in the seedlings compared with those in unstressed controls. Furthermore, Cd stress induced an imbalance in plant stress hormone levels and decreases in endogenous GSH levels and GSH redox ratios, which were correlated with reductions in ascorbate (AsA) and/or nicotinamide adenine dinucleotide phosphate (NADPH) redox states. However, the exogenous application of GSH to Cd-stressed *B. napus* seedlings reduced Cd-induced ROS levels and enhanced antioxidant-scavenging defenses and redox regulation by both increasing AsA, GSH, and NADPH concentrations and rebalancing stress hormones, thereby enhancing Cd uptake and accumulation. These results demonstrate that GSH improved plant redox status by upregulating the AsA-GSH-NADPH cycle and reestablishing normal hormonal balance. This indicates that exogenously applied GSH can mitigate Cd phytotoxicity in *B. napus* and possibly other plants. Therefore, antioxidant GSH can potentially be applied to Cd-polluted soil for plant remediation.

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