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γ-Aminobutyric acid (GABA) confers chromium stress tolerance in mustard (*Brassica juncea* L.) seedlings by modulating the antioxidant defense and glyoxalase systems

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Abstract

Chromium (Cr) toxicity is hazardous to the seed germination, growth, and development of plants. γ -Aminobutyric acid (GABA) is a non-protein amino acid and is involved in stress tolerance in plants. To investigate the effects of GABA in alleviating Cr toxicity, we treated eight-d-old mustard (*Brassica juncea* L.) seedlings with Cr (0.15 mM and 0.3 mM K_2CrO_4, 5 days) alone and in combination with GABA (125 µM) in a semi-hydroponic medium. The roots and shoots of the seedlings accumulated Cr in a dose-dependent manner, which led to an increase in oxidative damage [lipid peroxidation; hydrogen peroxide (H_2O_2) content; superoxide ($O_2^{\bullet-}$) generation; lipoxygenase (LOX) activity], MG content, and disrupted antioxidant defense and glyoxalase systems. Chromium stress also reduced growth, leaf relative water content (RWC), and chlorophyll (chl) content but increased phytochelatin (PC) and proline (Pro) content. Furthermore, supplementing the Cr-treated seedlings with GABA reduced Cr uptake and upregulated the non-enzymatic antioxidants (ascorbate, AsA; glutathione, GSH) and the activities of the enzymatic antioxidants including ascorbate peroxidase (APX), monodehydroascorbate reductase (MDHAR), dehydroascorbate reductase (DHAR), glutathione reductase (GR), glutathione peroxidase (GPX), superoxide dismutase (SOD), catalase (CAT), glyoxalase I (Gly I), and glyoxalase II (Gly II), and finally reduced oxidative damage. Adding GABA also increased leaf RWC and chl content, decreased Pro and PC content, and restored plant growth. These findings shed light on the effect of GABA in improving the physiological mechanisms of mustard seedlings in response to Cr stress.

Keywords: Toxic metal, Abiotic stress, Methylglyoxal, Amino acid, Reactive oxygen species

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