

Title Effects of exogenous salicylic acid and nitric oxide on lipid peroxidation and antioxidant enzyme activities in leaves of *Brassica napus* L. under nickel stress

Author Nader Kazemi, Ramazan Ali Khavari-Nejad, Hamid Fahimi, Sara Saadatmand and Taher Nejad-Sattari

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Abstract

The effects of nickel in combination with salicylic acid (SA) and sodium nitroprusside (SNP), a donor of nitric oxide (NO) on 21-day-old canola plants were evaluated. Exposure to 0.5 mM $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$ for 10 days resulted in toxicity symptoms such as chlorosis and necrosis at leaves. Addition of 0.2 mM SA or 0.2 mM SNP slightly reduced the toxic effects of nickel. After application of both SA and NO, these symptoms considerably decreased. Treatment with Ni resulted in a decrease in dry weight of roots and shoots and chlorophyll content of leaves. In Ni-treated plants, level of lipooxygenase activity and malondialdehyde (MDA), H_2O_2 and proline contents significantly increased, while the activities of the antioxidant enzymes such as catalase, guaiacol peroxidase and ascorbate peroxidase decreased in leaves. The results indicated that Ni caused an oxidative stress in canola plants. The Ni-stressed plants exposed to SA or NO, especially to SA + NO, exhibited an improved growth as compared to Ni-treated plants. SA or NO, especially both together considerably reduced root-to-shoot translocation of Ni and increased the activities of the antioxidant enzymes in leaves of Ni-stressed plants. Interaction of SA and NO improved the chlorophyll content and decreased the level of lipid peroxidation, H_2O_2 and proline accumulation in leaves. These results suggest that SA or NO in particular their combination counteract the negative effects of Ni on canola plants.