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研究论文

NO和H_2O_2诱导大豆根尖和边缘细胞耐铝反应的作用

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摘要 NO和H_2O_2是参与植物抗非生物胁迫反应的重要信号分子, 为了确定NO和H_2O_2在大豆(*Glycine max*)根尖和根边缘细胞(root border cells, RBCs)耐铝反应中的作用及其相互关系, 以‘浙春3号’大豆为材料, 研究了铝毒胁迫下大豆根尖内源NO和H_2O_2的变化, 以及外源NO和H_2O_2诱导大豆根尖和RBCs的耐铝反应。结果表明, 50 μmol·L^{-1} Al处理48 h显著抑制大豆根的伸长, 提高Al在根尖的积累, 同时显著增加根尖内源NO和H_2O_2含量。施加0.25 mmol·L^{-1}外源NO供体亚硝基铁氰化钠(Na_2[Fe(CN)$_5$NO]·2H_2O, sodium nitroprusside, SNP)和0.1 mmol·L^{-1} H_2O_2, 能有效地缓解Al对大豆根伸长的抑制、根尖Al积累和RBCs 的死亡, 该缓解作用可以被0.05 mmol·L^{-1} NO清除剂2-(4-羧基苯)-4,4,5,5-四甲基咪唑-1-氧-3-氧化物, 钾盐($C_{14}H_{16}N_2O_4$·K, carboxy-PTIO, cPTIO)和150 U·mL^{-1} H_2O_2清除酶(catalase, CAT)逆转。并且外源NO能够显著促进根尖H_2O_2的积累, 而外源H_2O_2对根尖NO的含量无显著影响。这表明NO和H_2O_2是诱导大豆根尖及RBCs耐铝反应的两种信号分子, NO可能通过调控H_2O_2的形成, 进而诱导大豆根尖及RBCs的耐铝反应。

关键词： 铝毒 H_2O_2 NO 根尖 根边缘细胞 大豆

Abstract: *Aims* Nitric oxide (NO) and hydrogen peroxide (H_2O_2) function as signaling molecules in plants. A role for NO and H_2O_2 in the regulation of many abiotic stress responses, including drought, salt, heat, heavy metal and Al stresses, has been proposed. Our objective was to investigate (a) the Al-dependent accumulation of endogenous NO and H_2O_2 in root tips and (b) the role of exogenous NO and H_2O_2 in alleviating Al toxicity in root tips and root border cells (RBCs).

Methods Seedlings of soybean (Glycine max) ‘Zhechun No. 3’ were divided into two groups for hydroponic and aeroponic cultured experiments. In order to investigate the response of endogenous NO and H_2O_2 in root tips to 50 μmol·L^{-1}Al, we determined root elongation, Al content in root apexes, endogenous NO and H_2O_2 content and their location in hydroponic cultured experiments. In the aeroponic culture experiments, seedlings were pretreated with exogenous NO and H_2O_2, then RBCs viability as well as the indicators in hydroponic cultured experiments were tested to clarify the role of exogenous NO and H_2O_2 on alleviating Al toxicity in root tips and RBCs.

Important findings Al inhibited root elongation, increased Al content in root apexes and induced endogenous NO and H_2O_2 accumulation with the hydroponic culture. Results of the aeroponic experiments demonstrated that both 0.25 mmol·L^{-1} NO donor sodium nitroprusside (SNP) and 0.1 mmol·L^{-1} H_2O_2 alleviated the inhibitory effect of Al, decreased Al accumulation in root tips and enhanced RBCs viability. The 0.05 mmol·L^{-1} NO scavenger cPTIO (carboxy-PTIO) and 150 U·mL^{-1} H_2O_2 scavenger CAT (catalase) reversed the alleviating effect. Furthermore, the results indicated that exogenous NO promoted the accumulation of H_2O_2 in root apexes, while exogenous H_2O_2 did not significantly affect NO content in root apexes. All of these results suggested that the rise of NO and H_2O_2 were in accordance with defense response in root apexes and RBCs to Al toxicity in soybean, and the increase of NO may regulate the H_2O_2 production to protect soybean from Al toxicity.

Keywords: Al toxicity, hydrogen peroxide, nitric oxide, root apex, root border cells, soybean

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