

## **Indole Acetic and Humic Acids Regulates Lateral Root Formation and Plasma Membrane H<sup>+</sup>-ATPase Using Nitric Oxide as Messenger**

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Although humic acids (HA) are known as an environmental auxin source, the mechanism of action of HA-mediated stimulation of plant development remains unclear. In this study we report that both indole-3-acetic acid (IAA)- and HA-enhanced lateral root (LR) development and plasma membrane (PM) H<sup>+</sup>-ATPase activity are related to nitric oxide (NO) production in the LR emission site. Maize seedlings treated with NO donor sodium nitroprusside (SNP 200 μM) exhibited an enhanced number of LRs similar to treatments with HA 20 mgC.L<sup>-1</sup> or IAA 0.1 nM. Both HA and SNP counteract the inhibitory effects of either the auxin-signaling pathway inhibitor [PCIB (*p*-Chlorophenoxyisobutyric acid)] or the efflux auxin inhibitor TIBA (2,3,5-triiodobenzoic acid). The SNP treatment was able to induce the LRs emergence even in the presence of these auxin inhibitors, however, the NO scavenger 2-phenyl-4,4,5,5-tetramethyl-imidazoline-1-oxyl-3-oxide (PTIO) blocked the SNP effects. Endogenous NO was detected by the specific probe 4,5-diaminofluorescein diacetate (DAF-2 DA) in sites of LRs emergence, pericycle, endodermis, protoxylem, metaxylem, companion cells, epidermal and outer cortical cells. The reminiscent effects of HA on seedlings treated with auxin inhibitors seems also to be related to NO signaling since the PTIO inhibition on HA effects were more pronounced than that from auxin inhibitors. The data suggest that HA can stimulate the PM H<sup>+</sup>-ATPase and maize root development by using NO as a messenger molecule.

Keywords: proton pumps, organic matter, acid growth

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