EXTRACELLULAR ATP SIGNALING INDUCES THE ACCUMULATION OF SUPEROXIDE VIA NADPH OXIDASES IN *ARABIDOPSIS THALIANA*

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Extracellular ATP, a well-characterized signal in mammalian cells, induces the production of reactive oxygen species in phagocytes by the catalytic action of NADPH oxidase. Consistent with it being a signaling agent also in plants, extracellular ATP induces the accumulation of superoxide in Arabidopsis leaves in a biphasic, dose-dependent manner between 1 μM and 100 μM ATP. Plants with disrupted AtrbohD and AtrbohF genes did not accumulate superoxide when treated with ATP, providing evidence that NADPH oxidases are responsible for the superoxide accumulation. Additionally, ATP induced increased levels of AtrbohD mRNA in a dose-dependent manner. Inhibitors of mammalian P2-type ATP receptors abolished ATP-induced superoxide production, suggesting that the ATP signal may be mediated through P2-like receptors in plants. Intermediate signaling roles for cytosolic Ca^{2+} and CaM are likely, because the Ca^{2+} channel blocker, $LaCl_3$, Ca^{2+} chelator, BAPTA, and CaM antagonist, W7, reduced ATP-induced superoxide accumulation. Extracellular ATP enhances the expression of genes that are induced by various stresses: PAL1, LOX2, and ACS6. ATP was measured at wound sites and found to be within the range to induce superoxide accumulation and gene expression changes. These data support a potential role for extracellular ATP as a signal especially in wound and stress responses.