IPK identifies protective mechanism against negative consequences of ammonium fertilisation

Press Release

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Gatersleben, 02.02.2022 **Although ammonium is an important inorganic nitrogen source for plants, high concentrations are toxic and can inhibit root growth at an early stage. An international research team led by the IPK Leibniz Institute has now identified a plant protection mechanism around vitamin B6, that plants can use to circumvent the negative side effects of ammonium supply. The results were published in the journal Molecular Plant.**

Nitrogen (N) is an essential mineral element for plant development and is widely used in crop production. While synthetic nitrogen fertilisers significantly improve global crop yields, the use of nitrate-based nitrogen fertilisers bears the risk of nitrate leaching or nitrogen oxide emission. Since ammonium is less prone to leaching than nitrate and is energetically cheaper to produce, ammonium-based fertilisers are often used in agricultural crop production.

To increase fertiliser use efficiency, ammonium is often applied in localised fertiliser strips where it is present in very high concentrations. Although ammonium is a preferred inorganic N source for many plant species, excessive ammonium causes toxicity that results in inhibited root elongation. This is a consequence of ammonium triggering a variety of physiological and morphological processes, including changes in pH, gene expression, ion transport, redox metabolism, phytohormone homeostasis, and root system architecture.

The research team found first that ammonium toxicity is related to an iron-dependent formation of reactive oxygen species (ROS) inside the root, which suppresses root elongation. "We then examined mutants of ammonium-induced genes in the roots and identified PDX1.1, a gene involved in the biosynthesis *de novo* of vitamin B6," explained Prof. Dr Nicolaus von Wirén, Head of the Department of Physiology and Cell Biology at the IPK Leibniz Institute.

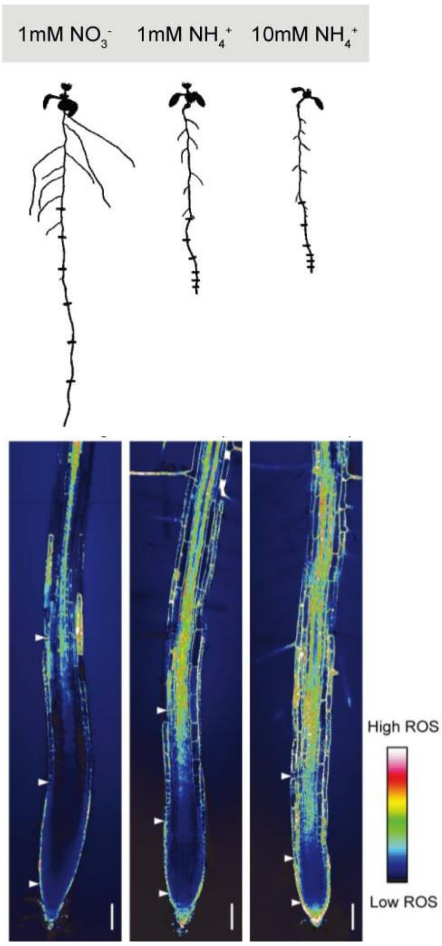
Pharmacological and genetic approaches, benefiting in particular from the collaboration with Prof. Dr. Teresa Fitzpatrick from the University of Geneva in Switzerland, then showed that non-phosphorylated forms of vitamin B6 suppressed H_2O_2 formation upon ammonium supply. "With PDX1.1-dependent vitamin B6 formation, our study was able to identify a natural protective mechanism that spatially coincides with ammonium-triggered H_2O_2 formation in inner root cells and thus has the potential to better adapt plant roots to ammonium-based fertilisation strategies," explained Prof. Dr. Nicolaus von Wirén.

Original publication:

Liu et.: PDX1.1-dependent biosynthesis of vitamin B_6 protects roots from ammonium-induced oxidative stress. Molecular Plant. DOI: 10.1016/j.molp.2022.01.012

Figure (for free use):

https://ipk-cloud.ipk-gatersleben.de/s/JRwXyDerpqmji2D



The illustration shows the shortened root growth of ammonium-fed Arabidopsis plants and the detection of reactive oxygen species (ROS) by a fluorescent ROS reporter. Figure: IPK Leibniz Institute