Versatile root exudates help plants surviving on calcareous soils

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PRESS RELEASE

- Publication in Nature Chemical Biology
- Iron mobilization by plants on calcareous soils

Gatersleben, March 27. **Elucidation of the biochemical pathway synthesizing coumarin-type iron chelators paves new ways to improve iron efficiency in crops. Researchers from the Leibniz Institute of Plant Genetics and Crop Plant Research (IPK) have discovered novel chemical features in iron mobilization by root exudates.**

Approximate one third of the world's soils are calcareous or have high pH, which makes iron precipitating and becoming sparingly soluble to plants. During evolution plants have developed different strategies to mobilize this sparingly soluble essential element. Under iron deficiency, many plant species release coumarin-type siderophores (standing for "iron carriers"), which diffuse through the rhizosphere and form complexes with ferric iron (Fe^{3+}). When reaching the root surface, these iron(III)-complexes are reduced by plasma membrane-bound reductases to release ferrous iron (Fe^{2+}) for subsequent uptake via divalent metal transport proteins. In collaboration with Elizabeth Sattely from Stanford University, California, a research team of the IPK has uncovered the missing steps in the biosynthesis of these coumarin-type siderophores that show an unexpected variability in their chemical structure and bear multiple beneficial properties.

"A surprising feature of these coumarin-type siderophores is their ability to reduce ferric iron during complexation" says Prof. Nicolaus von Wirén, head of the Department of Physiology & Cell Biology at IPK. "This feature facilitates the solubilization of soil iron and allows circumventing the reductase-mediated reduction of ferric iron before passage of Fe^{2+} through the plasma membrane. Moreover, these coumarin-type siderophores bear the potential to act as redox-shuttles, because their reduction at the plasma membrane could restore their capacity to reduce additional ferric iron ions from precipitates when travelling back to the soil."

Dr. Ricardo F.H. Giehl, who carried out the wet-bench experiments in the Molecular Plant Nutrition group at IPK discovered another interesting facet of these siderophores. “The amounts and types of coumarins presented in root exudates are altered by the pH of the rhizosphere. This is especially interesting, because we found that particular structural features of the various coumarin-type siderophores determine their complexation and reduction capacities. This functional versatility of coumarin-type siderophores is even increasing when looking beyond the model plant *Arabidopsis thaliana*, in which most molecular and biochemical experiments have been conducted so far.”

A major public/societal benefit in the discovery of coumarin-type siderophores, which builds on previous work describing the discovery of this novel type of iron chelators by the same group, lies in the development of iron deficiency-tolerant crop species. Using the genes underlying the enzymes required for coumarin biosynthesis will allow developing genetic markers that can be used in breeding and selection of lines with enhanced synthesis and release of iron-mobilizing siderophores to improve iron acquisition by crop plants cultivated on calcareous soils.

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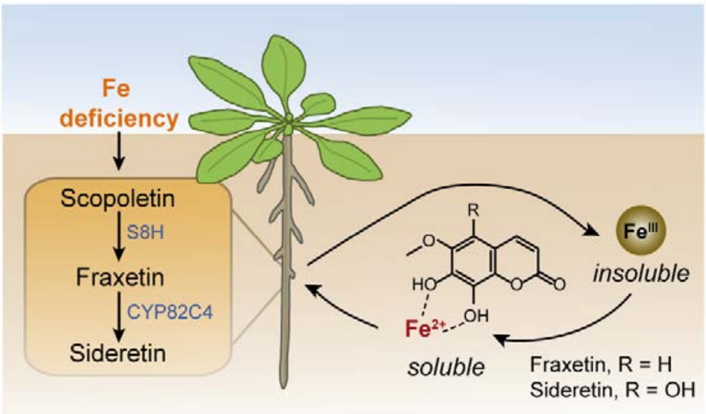
Figure (Seven Days download):



Iron (Fe) deficiency induces the synthesis of the coumarin-type siderophores fraxetin and sideretin by the enzymes S8H and CYP82C4, respectively. When released in the rhizosphere, these small molecules help plants mobilizing Fe from insoluble sources (Image: Ricardo FH Giehl and Jakub Rajniak).

Further Information:

The **Leibniz-Institute of Plant Genetics and Crop Plant Research** (IPK) in Gatersleben is one of the world's leading international institutions in the field of plant genetics and crop science. Its research programme and services contribute materially to conserving, exploring and exploiting crop diversity. Its research goals are driven by the need to ensure an efficient and sustainable supply of food, energy and raw materials, thereby addressing a major global ecological challenge.
www.ipk-gatersleben.de

Media Contact:

Regina Devrient, IPK
Geschäftsstelle des Direktoriums I Öffentlichkeitsarbeit
Tel. +49 039482 5837
E-Mail: devrient@ipk-gatersleben.de