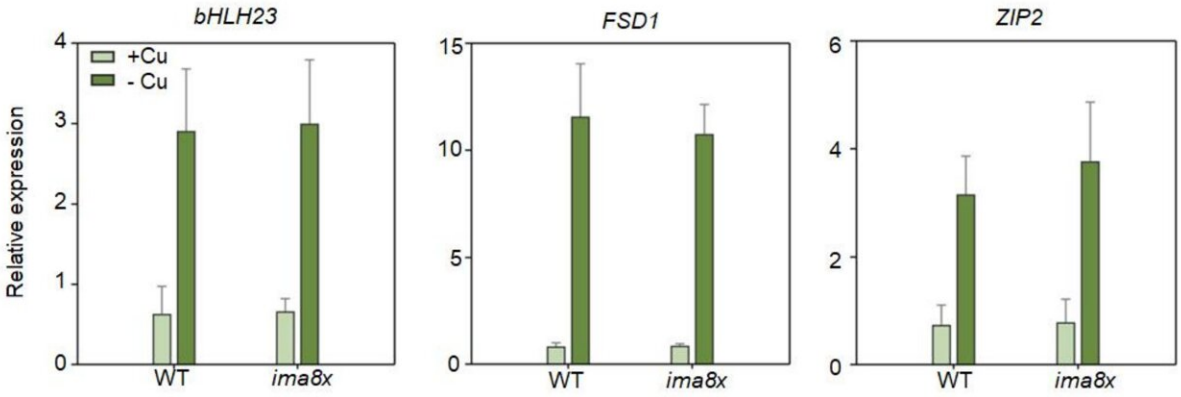
How IRON MAN (IMA) is involved in copper homeostasis in plants

December 6 2023, by ZHANG Nannan



Expression of bHLH23, FSD1 and ZIP2 in ima8x. Arabidopsis seedlings were grown on +Cu or –Cu medium for 7 days. Roots were used for RNA extraction and qRT-PCR. Three independent experiments were conducted with the similar results, and one representative experiment is shown. The data represent means ± SD(n=3 biological replicates). Credit: *New Phytologist* (2023). DOI: 10.1111/nph.19439

Copper (Cu) availability is critical for plant growth and development and for food yield and quality. It is essential for plants to maintain Cu homeostasis. To maintain Cu homeostasis in different tissues and organs, the uptake and transport of Cu must be precisely controlled. IRON MAN (IMA) is a family of small peptides that can bind both iron (Fe) and Cu ions.

IMAs have been reported to mediate Fe homeostasis in Arabidopsis thaliana. However, it remains unclear whether IMAs are involved in Cu homeostasis.

In a study published in *New Phytologist*, researchers from the Xishuangbanna Tropical Botanical Garden (XTBG) of the Chinese Academy of Sciences showed that IMAs interact with Cu-DEFICIENCY INDUCED TRANSCRIPTION FACTOR1 (CITF1) to maintain Cu homeostasis in plants.

The researchers first tested whether the expression of IMA genes is responsive to changes in Cu concentration and found that the transcription of IMA genes is repressed by Cu deficiency. Combined disruption of all IMA genes resulted in increased tolerance to Cu deficiency and increased transcript abundance of Cu uptake genes, whereas the overexpression of IMA1 or IMA3 had the opposite effect.

The researchers then performed protein interaction assay studies and found that IMAs interact with Cu-DEFICIENCY INDUCED TRANSCRIPTION FACTOR1 (CITF1), which is a positive regulator of the Cu uptake genes.

Furthermore, IMAs not only interfere with the DNA binding of CITF1, but also repress the transcriptional activation activity of CITF1, hence resulting in the downregulation of the Cu uptake genes. When Cu is sufficient, IMAs block CITF1 from binding to the promoters of the Cu uptake genes and stop CITF1 from activating the Cu uptake genes. When Cu is deficient, the expression of IMAs is repressed.

The results suggest that IMAs physically interact with CITF1 and negatively regulate the Cu-deficiency response by inhibiting the DNA binding and transcriptional activation.

"This study suggests that IMAs are a new component of the Cu deficiency response signaling pathway. It provides experimental support for the existence of a sophisticated system that allows plants to dynamically respond to Cu status," said Liang Gang of XTBG.

More information: Yuerong Cai et al, IRON MAN interacts with Cu-DEFICIENCY INDUCED TRANSCRIPTION FACTOR 1 to maintain copper homeostasis, *New Phytologist* (2023). DOI: 10.1111/nph.19439

Provided by Chinese Academy of Sciences