

# Effects of Lanthanum(III) on Copper(II) stressed rice (*Oryza sativa*) and its molecular mechanism revealed by transcriptome profiling

Yuqing Zhong<sup>1</sup> and Jiajia Chen<sup>1</sup>

<sup>1</sup>Suzhou University of Science and Technology

May 5, 2020

## Abstract

Rare earth elements are known to alleviate heavy metal stress. However, the potential mechanisms of alleviation remain unclear. This study compared the effects of La(NO<sub>3</sub>)<sub>3</sub> and La(NO<sub>3</sub>)<sub>3</sub>-amino acid chelates (La(III)-AA) on growth, oxidative stress, ultrastructure, bioaccumulation and gene expression in rice. Results demonstrated that 20 mg/L La(III)-AA can effectively ameliorate CuSO<sub>4</sub> (50 mg/L) stress in rice by reducing oxidative stress and increasing chlorophyll content, thus promoting growth. ICP and TEM revealed an antagonistic effect between La(III) and Cu(II). Exogenous La(III)-AA decreased Cu(II) content in rice leaves, stems and roots by 55.56%, 59.46% and 26.29%, and ameliorated Cu(II) damage by maintaining the ultrastructure of mesophyll cells. RNA sequencing identified 7020 differentially expressed genes, and 8 were validated by qRT-PCR. Indole-3-acetic acid (IAA) concentration was detected by HPLC. Correlation analysis between OsGH3.4-IAA-Expansin revealed that IAA content is negatively correlated with OsGH3.4 ( $r=-0.82$ ,  $P < 0.05$ ), and positively correlated with Expansin ( $r = 0.78$ ,  $P < 0.05$ ). It's assumed that La(III)-induced OsGH3.4 could inhibit IAA-dependent Expansin expression, thereby conferring resistance to Cu stress. This work provides novel insights into the molecular basis underlying La-induced Cu tolerance in rice.

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