【Grant-in-Aid for Scientific Research (S)】

**Broad Section F**

# Title of Project : Plasticity of mineral element transport system in response to soil environmental fluctuations in plants

MA Jian Feng
(Okayama University, Institute of Plant Science and Resources, Professor)

Research Project Number : 21H05034 Researcher Number : 80260389
Term of Project : FY2021-2025 Budget Allocation : 145,600 Thousand Yen
Keyword : Environmental changes, mineral element transport, rice, transporter, regulation, root

## 【Purpose and Background of the Research】

Due to global climate change, the frequency of heavy rains and droughts has increased in recent years, and the water content of soil has fluctuated significantly. As a result, concentrations and chemical forms of mineral nutrients in soil, which are essential for crop growth, have changed drastically. In addition, excessive chemical fertilizer application accelerates soil acidification, resulting in solubilization of toxic mineral elements, which affect both crop productivity and safety. The purpose of this study is to elucidate the plastic transport system of plants in response to soil mineral environmental changes. We will use rice as a model plant, which can grow under both flooded and upland soil condition. We will identify various mineral transporters that work under different soil conditions (flooding and upland), and characterize their functions, regulation mechanisms, and structures. In addition, we will use different approaches to investigate the sensing and signaling transduction mechanisms in response to environmental changes. Furthermore, using wild rice and the world's rice core collection, we will elucidate the evolutionary processes of acquiring the plasticity of these environmental responses.

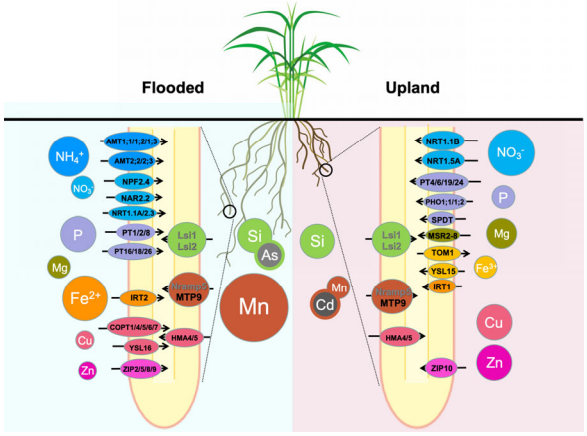


Figure 1 Changes of concentrations and chemical forms of mineral elements under different soil conditions and plastic response of mineral element transporters.

## 【Research Methods】

Firstly, we will isolate mineral transporter genes that function under different environmental conditions. We will then investigate their expression patterns and tissue/cellular localization by various methods. Tissue/cellular localization will be observed by immunostaining with specific antibodies or transgenic plants carrying tag-fused genes. In addition, to investigate the role of various transporters in different environments, we will use the CRISPR / Cas9 technique to generate knockout lines and compare their mineral element uptake with the wild-type rice. We will use ICP-MS for quantifying mineral elements in different tissues, and LA-ICP-MS for observing the tissue-dependent distribution of the elements. For transport activity assay, in addition to the yeast mutant, insect cells, and *Xenopus* oocyte expression systems, a unique proteoliposomal reconstruction system will be also used. We will investigate the phosphorylation, degradation, and ubiquitination of mineral transporter proteins under various conditions by specific antibodies and transgenic lines harboring tag-fused genes. Finally, we will elucidate the structure of some mineral transporters by utilizing cryo-electron microscope and X-ray crystal analysis.

## 【Expected Research Achievements and Scientific Significance】

We expect to elucidate the plasticity of the mineral element transport system of plants (rice) under the fluctuating soil conditions. Furthermore, we also attempt to understand the sensing and signal transduction mechanisms of mineral element transporters. Through structure analysis of some transporters, we hope to gain novel insight into how to exclude toxic mineral elements selectively from the uptake. These results will contribute to breeding new cultivars with smart response to future environmental changes and high safety.

## 【Publications Relevant to the Project】

・ Shao, J. F., Yamaji, N., Huang, S. and Ma, J.F. (2021) Fine regulation system for distribution of boron to different tissues in rice. *New Phytologist* 230: 656–668.
・ Wang, P., Yamaji, N., Inoue, K., Mochida, K. and Ma, J.F. (2020) Plastic transport systems of rice for mineral elements in response to diverse soil environmental changes. *New Phytologist* 226:156-169.

## 【Homepage Address and Other Contact Information】

http://www.rib.okayama-u.ac.jp/plant.stress/index-j.htm