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

Biological Sciences (Agricultural sciences)

Title of Project : Homeostasis of Plant Mineral Nutrients and Growth- Modeling of Overall Regulation

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Research Area : Plant Nutrition

Keyword : Mineral Nutrients, Transporter, Regulation, Modeling

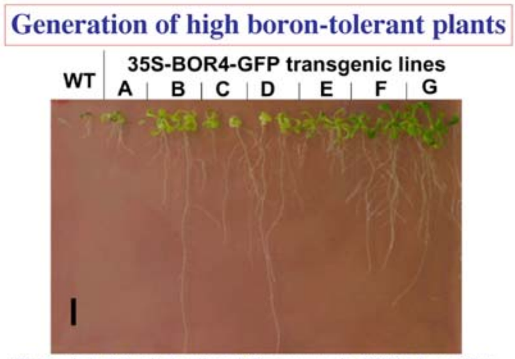
【Purpose and Background of the Research】

Our life depends on plants. Plants provide us with foods, medicines, woods, clothes etc. Plants cover the surface of the earth and absorb carbon dioxide to protect environments. This is all possible because plants, unlike us humans, can grow on mineral nutrients from soil. Seventeen essential elements are identified for plants and most of them are taken up by plants from soil. Depending on the origins, climate, etc., mineral contents in soil vary and in most cases they are not optimized for plant growth. Plants sense the levels of available nutrients in soil and modify uptake or exclusion rate of nutrients to maintain concentration of nutrients within the acceptable ranges. This process is the mineral nutrient homeostasis. Plants survival in various environments depends on the high capacity of mineral nutrient homeostasis.

The aim of this project is to study the mechanism of mineral nutrient homeostasis, namely sensing the nutrient levels, response mechanisms to regulate mineral nutrient transport processes.

We previously identified the first boron transporter in the living systems from a model plant *Arabidopsis thaliana*. We used a mutant that requires high levels of boron for normal growth. Mutant is a kind of plants that has defects in a certain process, in this case boron transport from roots to leaves. The gene that caused this particular mutant phenotype was identified through genetic mapping and it was found to be a boron transporter localized to plasma membrane.

We further identified several membrane proteins that are involved in boron uptake, transport, exclusion and distribution within plants. Accumulation of these transport proteins are found to be regulated in response to the boron nutritional conditions in the environment to maintain levels of boron transported to shoots. Moreover we successfully generated plants that tolerate low or high boron conditions by manipulating expression of boron transport proteins (Figure). We also identified the first molybdate transporter in eukaryotes by a molecular genetic approach using *A. thaliana*.



Transgenic Arabidopsis plant lines (A-G) overexpressing BOR4, a boron efflux transporter, were grown on plates containing 10 mM boric acid. Compared with the wild type plants (WT), transgenic lines grew better.

【Research Methods】

In this project, we apply similar approaches to other important nutrients. Mutants with altered response or growth properties to nutritional conditions will be isolated and the corresponding genes will be identified to reveal novel mechanisms of mineral nutrient homeostasis. We will also build a quantitative model to understand overall regulation of mineral nutrient transport within plants, with the emphasis on boron, incorporating different roles of transporters to maximize plant growth.

【Expected Research Achievements and Scientific Significance】

Novel mechanisms of mineral nutrient homeostasis will be revealed. A quantitative model for regulation of mineral nutrient transport will be established. These findings will be useful for generating plants tolerate various nutritional stresses and contribute to food production and environmental protection.

【Publications Relevant to the Project】

- Takano, J., Miwa K, Fujiwara, T. Boron transport mechanisms: collaboration of channels and transporters. *Trends in Plant Science*, 13: 451-457. (2008)
- Miwa, K., Takano, J., Omori, H., Fujiwara, T. Plants tolerant of high boron levels. *Science* 318,1417 (2007)

【Term of Project】 FY2009-2013

【Budget Allocation】 160,700 Thousand Yen

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