【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 nutrient, transporter, sensing, regulation, mathematical model

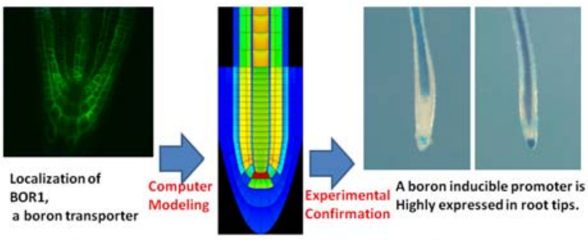
【Purpose and Background of the Research】

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 animals, 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, BOR1, in the living systems and revealed its unique regulation and localization (Kasai et al). We also identified NIP5;1, a influx transporter required for efficient uptake and recently revealed that the regulation by boron is at the level of mRNA degradation. Moreover we successfully constructed 2D-mathematical model that incorporate special pattern of boron transporters to calculate boron distribution in roots and the pattern of boron distribution is experimentally assessed (Figure). This, to our knowledge, is the first construction and experimental examination of special model of nutrient transport in plants.



Model Construction and Experimental Confirmation of Boron transport/distribution in roots

【Research Methods】

In this project, we further develop mathematical model so that it can be applied to a wide range of nutrients and plant species. We als study ,utants with altered response or growth properties to nutritional conditions and further understand the mechanisms of mineral nutrient homeostasis. We will also take a careful look into the novel mechanisms of nutrient-responsive gene regulation through mRNA degradation.

【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】

- Boron-Dependent Degradation of NIP5;1 mRNA for Acclimation to Excess Boron Conditions in Arabidopsis.Tanaka, M.,Takano J., Chiba, Y., Lombardo, F., Ogasawara, Y., Onouchi, H., Naito, S. and Fujiwara, T. ***Plant Cell*** 23(9):3547-59 (2011)
- High boron-induced ubiquitination regulates vacuolar sorting of the BOR1 borate transporter in Arabidopsis thaliana. Kasai K, Takano J, Miwa K, Toyoda A, Fujiwara T. ***J Biol Chem.*** 286(8): 6175-6183 (2011)

【Term of Project】 FY2013-2017

【Budget Allocation】 166,700 Thousand Yen

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