Division of Biochemistry
- Molecular Biology -

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Visitors

Dr MELE, Giovanni	National Research Council of Italy, Italy, 4–11 April 2009
Dr LAMBREVA, Maya	National Research Council of Italy, Italy, 4–11 April 2009
Ms LOMBARDI, Benedetta	University of Rome La Sapienza, Italy, 9–14 June 2009
Prof QU, Li-Jia	College of Life Science, Peking University, China, 26–31 August 2009
Dr QIN, Genji	College of Life Science, Peking University, China, 26–31 August 2009
Dr HONG, Long	College of Life Science, Peking University, China, 26–31 August 2009
Dr LIU, Jingjing	College of Life Science, Peking University, China, 26–31 August 2009

Scope of Research

This laboratory aims at clarifying molecular bases of regulatory mechanisms for plant development, especially plant morphogenesis, with techniques of forward and reverse genetics, molecular biology, and biochemistry. Current major subjects are phospholipid signalings in cell morphogenesis, the transcriptional network for cytokinin responses, COP9 signalosome modulating signal transduction in the nuclei, and the endoreduplication cell cycle in cell differentiation.

Research Activities (Year 2009)

Publications

Aoyama T: Phospholipid Signaling in Root Hair Development. *Root Hairs, Excellent Tools for the Study of Plant Molecular Cell Biology* (*eds., Emons A.M.C., Ketelaar T, Springer, Berlin Heidelberg New York*), 171-189 (2009).

Kusano H, Aoyama T: Mechanism Establishing and Sustaining the Polarity in Root Hair Morphogenesis: Focusing on Phospholipid Signaling. *Tanpakushitu Kakusan Koso*, **54**, 649-655 (2009).

Presentations

COP9 Signalosome: The Key Modulator of Signal Transduction in Plants and Mammals, Tsuge T, Invited Lecture at National Research Council of Italy, 9 February 2009 (Rome).

Phospholipid Signals for the Regulation of Plant Cell Polarity, Aoyama T, Symposium of Young Global Research Leader Promotion Program, 11 November 2009 (Shizuoka).

Grants

Aoyama T, Mechanism of Cytokinin Signal Transduction by the Response Regulator ARR1, Grant-in-Aid for Scientific Research (B) (2), 1 April 2009–31 March 2012.

Aoyama T, Role of Phospholipid Signals in Plant Cell Morphogenesis, Grant-in-Aid for Scientific Research on Priority Areas, 1 April 2009–31 March 2011.

Aoyama T, Signal Transduction from Nutrient Conditions

Involvement of Phospholipase Dζ2 in Root Hydrotropism

Water deficiency is a frequently occurring difficulty for plants growing in natural fields. To survive this adversity, land plants are equipped with various means of altering their metabolism, morphology, and developmental processes. Of these, root hydrotropism, directional growth of roots toward moisture, is the most active means that plants can exert in the early stages of water deficiency. Root hydrotropism has been described for many plant species, including peas and maize. During the root hydrotropic response, the root cap senses a moisture gradient and transfers the signal to the root cell elongation zone, where asymmetric cell elongation results in root curvature. The involvement of calcium ions, auxin, and abscisic acid (ABA) in the signaling for this response has been revealed by genetic and physiological studies. From *Arabidopsis thaliana*, mutants specific to this response have been obtained. Moreover, in *Arabidopsis*, water deficiency is supposed to suppress root gravitropism to prioritize root hydrotropism. However, the mechanisms are still unclear, not only for the establishment of root hydrotropism, but also the suppression of root gravitropism under water-deficient conditions.

We found that the promoter activity of the *Arabidopsis* phospholipase Dζ2 gene (*PLDζ2*) was localized to epidermal cells in the distal root elongation zone and lateral root cap cells adjacent to them (Figure 1), and that exogenous ABA enhanced the activity and extended its area to the entire root cap. Although *pldζ2* mutant root caps did not exhibit a morphological phenotype in either the absence or presence of exogenous ABA, the inhibitory effect of ABA on gravitropism, which was significant in wild-type roots, was not observed in *pldζ2* mutant roots. In root hydrotropism experiments, *pldζ2* mutations significantly retarded or disturbed root hydrotropic responses (Figure 2). A drought condition similar to that used in a hydrotropism experiment enhanced the *PLDζ2* promoter activity in the root cap, as did exogenous ABA. These results suggest that *PLDζ2* responds to drought through ABA signaling in the root cap and accelerates root hydrotropism through the suppression of root gravitropism.

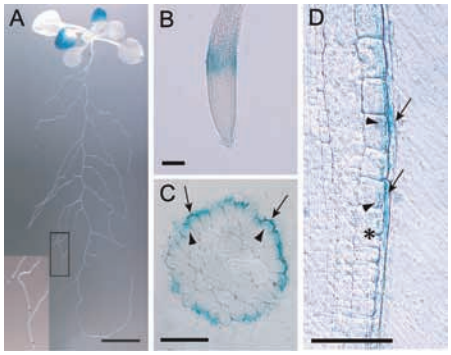

Figure 1. Histochemical analysis of the *PLDζ2* promoter. The *PLDζ2* promoter activity was histochemically analyzed using transgenic plants carrying the pPLDζ2-GUS gene at 10 days after germination. A: Seedling, B: Main root tip, C: Transverse section of a root in the transition zone, D: Longitudinal section of a root in the transition zone. An inset in (A) shows a magnified picture of the part encompassed by the square. Arrows and arrowheads indicate the lateral root cap and epidermal cells that exhibit GUS activity, respectively, in (C) and (D). An asterisk indicates the lower boundary of elongating epidermal cells in (D). Bar = 5 mm (A), 0.1 mm (B), and 0.05 mm (C, D).

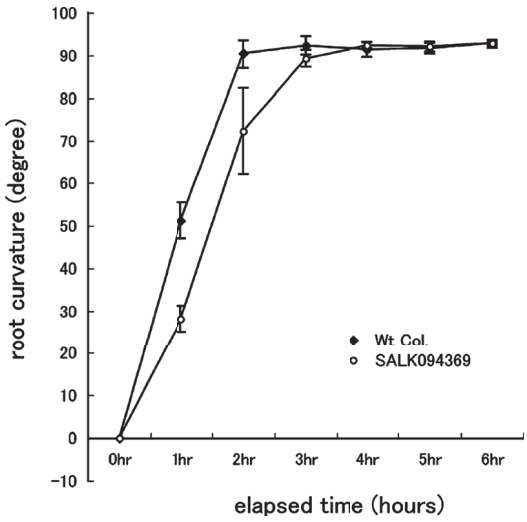

Figure 2. Hydrotropism analysis of *pldζ2* mutant roots. Wild-type (Wt Col.) and *pldζ2* mutant (SALK094369) plants were examined for their root hydrotropism under the moisture-gradient condition in a closed chamber. The angles of root curvature were measured every hour, and mean values were plotted. Error bars represent SE.

to Root Hair Morphogenesis, Grant-in-Aid for Scientific Research on Priority Areas, 1 April 2008–31 March 2010.

Tsuge T, Molecular Mechanism Conserved in Human Carcinogenesis Regulation and Plant Photomorphogenesis Regulation, Research Grant (Ito Kagaku Shinkou Foundation), 1 December 2008–31 March 2010.

Tsuge T, Understanding Plant Signal Transduction to Improve Solar Energy Usage, Research Grant (The Iwatani Naoji Foundation), 1 April 2009–31 March 2010.

Tsuge T, Qu LJ, Molecular Mechanism Involved in Maintaining the Flatness of the Leaf Blade, Japan-China Scientific Cooperation Program (JSPS), 1 April 2007–31 December 2009.

Tsuge T, Mele G, Transcriptional Regulations on Higher Plants by COP9 Signalosome, Japan-Italy Scientific Cooperation Program (JSPS), 1 April 2008–31 March 2010.