

【Grant-in-Aid for Scientific Research(S)】
Biological Sciences (Agricultural sciences)



Title of Project : “Speaking Cell Approach” by on-site/real-time cellular and molecular measurements

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Research Area : Agricultural Engineering

Keyword : Cell and Tissue, Plants, Mass Spectrometry

【Purpose and Background of the Research】

In FY2011, a plant growth factory complex was built in the Faculty of Agriculture, Ehime University. After the Great East Japan Earthquake and Tsunami (2011), the Science Council of Japan published a recommendation, which encouraged the building of plant growth factories in order to secure the nation’s food supply and food security. This project is related to the development of a new control system to operate plant growth factories more efficiently in the future.

By using physiological molecular information, environmental conditions can be adjusted optimally to grow crops in plant growth factories. Such a control method using physiological information to optimize energy efficiency and product quality control in plant growth factories is known as the “speaking cell approach” (SCA). In the present study, methods for on-site/real time cellular and molecular measurement techniques will be developed by using a cell pressure probe and probe electrospray ionization mass spectrometry for SCA.

【Research Methods】

A cell pressure probe measures the cell turgor of plants, and can extract cell solution directly from actively growing plants. The pressure probe technique and the probe electrospray ionization (PESI) mass spectrometry (MS) can be combined together in order to analyze cell molecular components in intact growing crops. The needle probe tip in PESI will be made to a scale as small as tens nanometers in tip diameter. The probe tip can be used to pick up molecules from cells. The thickness of cell walls of plants is about 200 nm, and if some molecules can be picked up from intact growing cells with the PESI probe, molecular components reflecting plant growth can be monitored. In the present project, the nano-precision PESI-MS technique will be developed for the purpose of introducing SCA in plant factories (i.e., Nano-Precision Agriculture).

【Expected Research Achievements and Scientific Significance】

The pressure probe-combined PESI-MS will offer nano-scale resolution of molecular profiling in cells, leading to nano-precision agriculture for automated greenhouses. PESI can induce ionization of mixture samples with no special sample preparations. Nano-scale cell manipulation and MS analyses will make it possible to get physiological information for SCA in plant growth factories, resulting in high efficiency of energy usage and high quality production.

【Publications Relevant to the Project】

- Nonami, H. (2001) Water Relations in Plant Physiology (Japanese). Yokendo Ltd., Tokyo, pp.263.
- Yu, Z., Chen, L.C., Erra-Balsells, R., Nonami, H., Hiraoka, K. (2010) Real-time reaction monitoring by probe electrospray ionization mass spectrometry. Rapid Communications in Mass Spectrometry 24 (11), pp. 1507-1513.
- Yu, Z., Chen, L.C., Suzuki, H., Ariyada, O., Erra-Balsells, R., Nonami, H., Hiraoka, K. (2009) Direct profiling of phytochemicals in tulip tissues and in vivo monitoring of the change of carbohydrate content in tulip bulbs by probe electrospray ionization mass spectrometry. Journal of the American Society for Mass Spectrometry 20 (12), pp. 2304-2311.
- Yousef Gholipour, Hiroshi Nonami, and Rosa Erra-Balsells (2008) Application of pressure probe and UV-MALDI-TOF MS for direct analysis of plant underivatized carbohydrates in subpicoliter single-cell cytoplasm extract. Journal of the American Society for Mass Spectrometry 19: 1841–1848.

【Term of Project】 FY2012-2016

【Budget Allocation】 152,600 Thousand Yen

【Homepage Address and Other Contact Information】

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