DEVELOPMENT OF NOVEL HYDROPONIC CULTURE SYSTEM FOR REAL-TIME MONITORING OF ROOT AND LEAF OF LETTUCES

Toshihiro Kasama[1,*], Wojciech Piotr Bula[1], Yoshishige Endo[1], Takumi Okamoto[2], Hoang Anh Tuan[2], Tetsushi Koide[2], Chiharu Sone[3], Masashi Komine[3], Atsushi Ogawa[3] and Ryo Miyake[1]
[1]Department of Bioengineering, The University of Tokyo, Tokyo, Japan
[2]Research Institute for Nanodevice and Bio Systems, Hiroshima University, Hiroshima, Japan
[3]Faculty of Bioresource Sciences, Akita Prefectural University, Akita, Japan

* Email: kasama@g.ecc.u-tokyo.ac.jp; Tel.: +81-44-589-6531

We have developed hydroponic culture system for lettuce, which has enabled continuous monitoring of the primary root and the lateral roots as well as the leaves. By using the system and image analysis technique, the total surface area of the roots and the leaves has been estimated in real-time. Our hydroponic culture system has a great potential to reveal the plant physiological state.

A number of studies have investigated the growth of roots under various conditions [1-3]; however, to our knowledge, the real-time analysis of the roots has not been performed. The aim of our research is to reveal the flow of nutrient and water inside the plant and to construct the plant model through the observation and analysis of the whole plant. In the present study, we selected lettuces as target plant which allow us to culture hydroponically in a matter of weeks.

Pictures of the hydroponic culture system are shown in Fig. 1. 0.2 % (v/v) Hyponica culture solution (Kyowa Co. Ltd, Osaka, Japan) in water circulated from the polypropylene tank, the clear tank (polymethyl methacrylate, 560 mm width, 800 mm length, 50 mm depth) to the drain. Its depth in the clear tank was 10 mm. Polystyrene board with 10 holes (30 mm in diameter) floated on the solution. To obtain homogeneous distribution of the nutrient in the clear tank, it is important to make sure that the laminar flow of the nutrient solution in the clear tank is established. Retention causes the depletion of nutrient. We realized the laminar flow of the nutrient solution by using sponges. The barrier of sponges adjusted the pressure of the solution (Fig. 2). Lettuce seedling was cultured in each hole. Therefore, the roots of lettuce spread almost two-dimensionally in the clear tank. To avoid light exposure against the roots, the lower part of the clear tank was covered by black boards. There was the hydroponic culture system in a facility for cultivation in which 18 h day/6 h night cycle was provided with white LED lights and the temperature was maintained at 25℃ and at 20℃ during the day and night, respectively. By using cameras, photographs of the roots were taken from underneath every 3 hours.

Fig. 3 shows examples of lettuces cultured in the developed system. It seemed likely that both of the leaves and roots of two lettuces had almost the same size. Currently, we are testing the analysis of captured images of the lettuces.

Word Count: 407

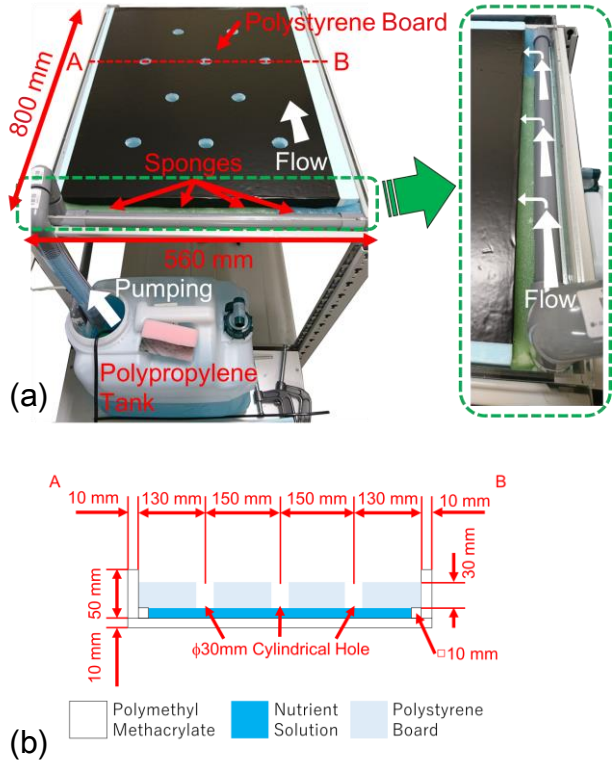

Fig.1 Photographs of the developed hydroponic culture system. (a) Top view and, (b) cross section of the clear tank, and (C) bottom view.

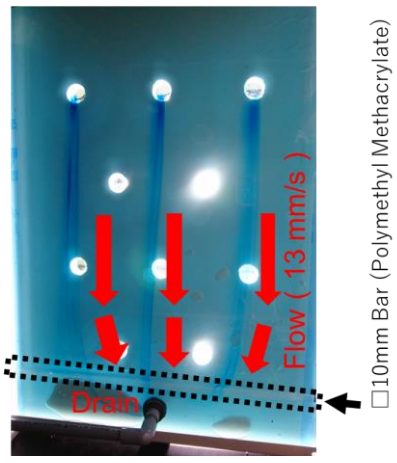

Fig. 2 Laminar flow of the nutrient solution in the clear tank.

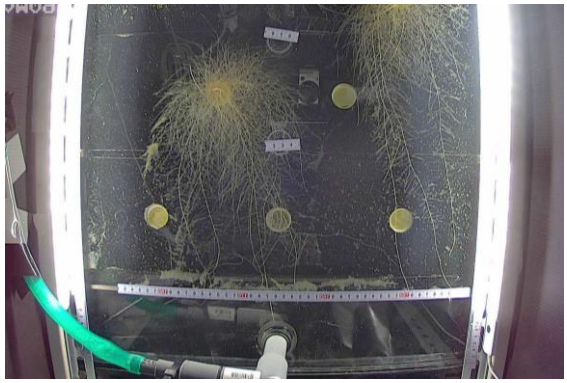

Fig. 3 Two lettuces cultured in the developed system.

REFERENCES:

[1] M. Gallardo, L. Jackson and R. Thompson, "Shoot and root physiological responses to localized zones of soil moisture in cultivated and wild lettuce (Lactuca spp.)", Plant Cell Environ, **1996**, 19, 1169-1178.

[2] M. Drew, "Comparison of the effects of a localised supply of phosphate, nitrate, ammonium and potassium on the growth of the seminal root system, and the shoot, in barley", New Phytologist, **1975**, 75, 479-490.

[3] D. Robinson, "The responses of plants to non-uniform supplies of nutrients", New Phytologist, **1994**, 127, 635-674.