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# Plant root PET: visualization of photosynthate translocation to roots in rice plant

Photosynthate translocation from source leaves to sink organs directly affects dry matter accumulation there and promotes auxetic growth of the sink tissues. In particular, the photosynthate translocation to root tissue is an important physiological function that affects growth of roots and determines plant growth, yield and quality. It is essential to evaluate the dynamics of photosynthate translocation to roots in crop cultivation. However, only a few studies have investigated the dynamics of translocation to roots because of the difficulty in measuring translocation to roots with three-dimensional and complex structure in the underground. Although positron emission tomography (PET) offers three-dimensional images of radioactive tracers and applied to plant root imaging [1], the spatial resolution of conventional PET scanners is degraded in the peripheral area of the field of view (FOV) due to parallax error. Because of the root structure, uniform spatial resolution is required. Four-layer depth-of-interaction detectors were developed to overcome the problem and applied to a small OpenPET prototype [2]. Recently, Kurita, et al. have improved the prototype for plant studies and imaged a piece of strawberry fruit at the center of the FOV [3]. In this study, we performed an imaging experiment of rice roots using the prototype and demonstrated the imaging capability of the prototype over the whole FOV.

Figures 1(a) and (b) show the material plant and the experimental setup. A rice plant three weeks after sowing was planted in a plastic pot (diameter of 97 mm, length of 140 mm). The PET was placed vertically in this study. About 34.8 MBq of 11CO2 gas was fed to all source leaves, and 30 min after the injection of 11CO2, the plastic pot was set in the center of the FOV (diameter of 110 mm, length of 145 mm) so as to position the source leaves outside the FOV. Then, the measurement was started and the 11C distribution images were acquired for 120 min. Above the PET, a light-emitting diode lamp was set to promote the photosynthesis of source leaves. The PET data were reconstructed using the ordered subset expectation maximization method. The matrix size and voxel size of the reconstructed images were $76 \times 76 \times 84$ and $1.5\ \text{mm} \times 1.5\ \text{mm} \times 1.5\ \text{mm}$, respectively.

Figure 2 shows the integrated PET images viewed from different planes. From these images, the 11C-photosynthate accumulation in roots which developed in three dimensions from the base to the peripheral area of the FOV in the underground were confirmed. We demonstrated the imaging capability of the prototype over the whole FOV successfully.

[1] S Jahnke et al., Plant J. 59 (2009), 634-644
[2] E Yoshida et al., Radiol. Phys. Technol. 5 (2012), 92-97
[3] K Kurita et al., Nucl. Instrum. Methods Phys. Res. Sect. A 954 (2020), 161843

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