実験報告書様式（一般利用課題・成果公開利用）

（ ※本報告書は英語で記述してください。ただし、産業利用課題として採択されている方は日本語で記述していただいても結構です。）

CROSS TOKAI Experimental Report J-PARC

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実験課題名 Title of experiment
Non-destructive analysis of rice and soybean root architecture using neutron radiography.

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装置名 Name of Instrument/（BL No.）
BL-22

実施日 Date of Experiment
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試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。（適宜、図表添付のこと）
Please report your samples, experimental method and results, discussion and conclusions.　Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.

[Samples]

Rice and Soybean (plant material C 46%, O 41%, H 6%, N 3%, Ca 2%, K 1%, others 1%, 150mm in height, 10 g) in aluminous plant box (Fig. 1).

300 mm x 300 mm (1000 g-1200 g/sample)

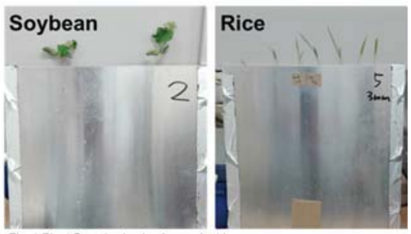

Fig. 1 Plant Samples in aluminous plant box.

2. 実験方法及び結果（実験がうまくいかなかった場合、その理由を記述してください。）

Experimental method and results.　If you failed to conduct experiment as planned, please describe reasons.

[Experimental method]

Measurement conditions: atmosphere pressure, at normal temperature

Sample conditions: Soil(solid), Water (liquid), Plant (plant material)

Measurement layout: downstream position (L=23m)

Beam power: 500 kW - 200kW

Shutter: Open-3, RC1:　102 mm, RC2:　128mm or 131mm

T0 chopper: 25Hz, Disk chopper: open stop (up & down), Filters: no

FoV: 300 mm (1335px, 1320 px) = (200mm, 200mm)→ (0.1498mm/px, 0.1515mm/px) → 0.15mm/px

Stage: (X,Y,Z)=(0,300mm,300mm)=(0,90000 pulses, 90000 pulsed)

2. 実験方法及び結果（つづき） Experimental method and results (continued)

In this study, we aimed to optimize the observation conditions for visualizing the root architecture of rice and soybean using imaging analysis by two-dimensional neutron radiography in soil. If it reveals that pulse neutron radiography suit for the acquisition of plant root architecture images in soil, pulse neutron radiography become a strong tool for screening of genetic resource for crop breeding and it helps to identify the genes to relate root plasticity under various growth conditions.

[Results1]

First, to investigate the exposure time and spatial resolution, the images of rice and soybean grown in two aluminous plant boxes of different thickness (3, 5 mm) filled with quartz sands were acquired. We used only 5 mm plant box in thickness because soybean seeds are large. Representative images were shown in Fig. 2.

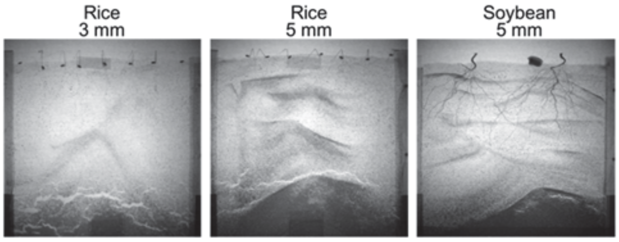

Fig. 2 2D root architecture images from the value of penetration probability at each pixels in different thickness aluminous plant boxes.

We found that the thickness of aluminous plant boxes does affect the value of penetration probability at each pixel and 3mm in thickness is the best to separate root shape from its surrounding quartz sands. The field of view and partitioning of 300 x 300 mm area were also examined from the view point of spatial resolution and exposure time and one partitioning (300 x 300 mm area) was selected for onward experiment.

From acquired images of rice and soybean using neutron radiography, we extracted the value of penetration probability at each pixel to separate root shape. The resulting 2D root architecture images showed that the rice roots were too thin to identify from its surrounding quartz sands. The difference of penetration probability between rice root and sands were not enough to separate its root from background because high water contents in soil. The images of soybean were analyzed using WinRizho software and obtained quantitative estimates of the root architecture trait manually. We set up the next experimental task to select cultivated soil for better root separation from background using neutron radiography.

[Results2]

To investigate the influence of soil type on the 2D image of penetration probability using neutron radiography, we examined three different types of cultivating soils (i.e. Mikawa silica sand, small glass beads, and the mixture of large and small glass beads). In any case, water draining was done as much as possible before exposure. Representative images were shown in Fig.3.

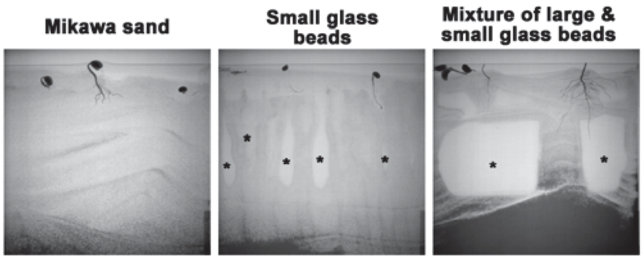

Fig. 3 Effects of difference soil type on the images of two-dimensional neutron radiography
Astarisks indicated the predicted air pockets in soil.

As a result, the soil background of the Mikawa silica sand shows much clear image than other two types of spoils, and it was impossible to distinguish the root from surrounding soil. Small glass beads, and the mixture of large and small glass beads also showed lower background noise than last time. However, spaces like air pockets were observed in the soil (see Fig.3 asterisks). Therefore, The Mikawa silica sand showed best result and it was easy to separate the soybean root from surrounding parts.

[Discussions]

The water content difference between soil and plant root were smaller than predicted value, and we concluded that it is impossible to quantify the root of rice that has thin roots of less than 400 um occupy most of the rhizosphere under this exposure conditions. For soybean, it is possible to quantify roots manually, but to measure many samples it is necessary to distinguish its root easily from the background using glass beads or high-grade silica sand as that soil. Glass beads generally have poor retention of water and are not suitable as soil for cultivating plants. It showed that it is a realistic option to allow some background noise and to use Mikawa silica sand for future study.

Images in Mikawa silica sands are quite clear than other sands. We may be able to use larger cultivation pot for soybean growth, and try to do 3D root architecture anaylysis.