Title
Non-invasive imaging of cadmium distribution in intact oilseed rape plants

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Cd is one of the toxic heavy metals. Cd is known as a carcinogen and a strong mutagen. Cd accumulation in the human body causes serious health problems. Because Cd is taken via farm products, it is necessary to reduce Cd accumulation in these products. To reduce Cd accumulation in these products, we need an elucidate mechanism of Cd distribution in plants. However, these mechanisms are not fully elucidated so far. Recently, positron-emitting nuclides have been used in plants in order to observe the distribution of several nutrients such as ^{52}Mn (Tsukamoto et al. 2006) and so on. The movements of these nuclides were monitored using the positron-emitting tracer imaging system (PETIS) (Fujimaki 2007). PETIS allows us to investigate the real-time movement of positron-emitting nuclides in intact plants non-invasively and to characterize the absorption, transport and accumulation of Cd in plants quantitatively. In our experiments, we selected oilseed rape plants because the Brassicaceae family is a Cd-tolerant and Cd-accumulator. Additionally, we established the methods of collecting xylem and phloem exudates from these plants (Nakamura et al. 2005 & 2008). The purpose of our work is to clarify these mechanisms by visualizing Cd absorption, transport and accumulation non-invasively using PETIS.

Oilseed rape plants (*Brassica napus* L. var. Nourin No.16) were grown hydroponically for two or four weeks. The nutrient solution used in our experiments was a modified Hoagland solution (Nakamura et al 2008). This solution was aerated and renewed every week. These seedlings were grown in a growth chamber at 24:16 ºC (light: dark, 16: 8 h) under a light intensity of about 250 µmol photons $m^{-2}s^{-1}$. Cd was added to the nutrient solution as $CdCl_2$. After Cd treatment for two days, the four-week-old seedlings were harvested. Cd concentration in these plants was determined using an inductively coupled plasma spectrometry (IRIS Duo; Nippon Jarrell-Ash, Kyoto, Japan). ^{107}Cd used in our experiments was produced according to the method established by Ishioka et al. 2006. PETIS experiments were performed in the growth chamber where the growth conditions of plants were controlled completely. In these PETIS experiments, two-week-old seedlings were used in order to monitor Cd distribution in whole plants. After setting plants in the chamber, PETIS experiments were started with addition of purified ^{107}Cd into nutrient solutions. 10µM Cd was also added as a carrier to these solutions.

After Cd treatment for two days, we could not investigate symptom of stress by Cd. In shoots and roots, Cd accumulated approximately 0.4 and 4.0 µmol g^{-1}(dry weight), respectively. Cd concentration in roots was higher than that in shoots in oilseed rape plants. We succeeded to obtain serial images of cadmium distribution in oilseed rape plants for 36 hours by every four minutes using PETIS. Strong ^{107}Cd signals were observed in the basal region of the shoot. We also could see strong signals in the node of oilseed rape plants. Our results suggested that nodes were playing important roles in distributing Cd to shoots in oilseed rape plants.

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