

PET Radiotracer Imaging in Plant Biology

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The ability to detect the emissions of radioactive isotopes through radioactive decay (e.g. beta particles, x-rays and gamma-rays) has been used for over 80 years as a tracer method for studying natural phenomena. The Hungarian-born chemist George de Hevesy in 1913 while in Vienne published with Fritz Paneth the first account of the use a radioactive isotope as a tracer in a paper titled: "The Solubility of Lead Sulphide and Lead Chromate." In 1923 Hevesy published his studies on the transport of the radioisotopes lead-210 and lead-212 in living plants. In 1948 in a University of California Radiation Laboratory report Melvin Calvin and Andrew Benson describe research into photosynthesis of brown algae using the radioactive tracer carbon-14. More recently a positron emitting radioisotope of carbon: carbon-11 has been utilized as a $^{11}\text{CO}_2$ tracer for plant ecophysiology research. Because of its ease of incorporation into the plant via photosynthesis, the $^{11}\text{CO}_2$ radiotracer is a powerful tool for use in plant biology research. Positron emission tomography (PET) imaging has been used to study carbon transport in live plants using $^{11}\text{CO}_2$. Presently there are several groups developing and using new PET instrumentation for plant based studies. Instrumentation originally developed for small animal PET has been modified for imaging ^{11}C in plant research as currently undertaken at Institute Phytosphere, Forschungszentrum Jülich in Germany. A two-headed planar PET plant imaging system for ^{11}C has also been described and used in plant studies by a research group at the Japan Atomic Energy Agency. At Brookhaven National Laboratory researchers have used a clinical human PET scanner to track the distribution of ^{11}C labeled metabolites in plants in response to environmental changes. The group I head at Thomas Jefferson National Accelerator Facility (Jefferson Lab) in collaboration with the Duke University Phytotron is also involved in PET detector development for plant imaging. In this presentation I will provide a brief overview of radiotracer imaging in plants and review some of the latest developments of the use of $^{11}\text{CO}_2$ tracer in plant studies of others as well as the developments of the Jefferson Lab/Duke University effort.