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Labelling plants the Chernobyl way: A new approach for mapping rhizodeposition and biopore reuse

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A novel approach for mapping root distribution and rhizodeposition using 137Cs and 14C was applied. By immersing cut leaves into vials containing 137CsCl solution, the 137Cs label is taken up and partly released into the rhizosphere, where it strongly binds to soil particles, thus labelling the distribution of root channels in the long term. Reuse of root channels in crop rotations can be determined by labelling the first crop with 137Cs and the following crop with 14C. Imaging of the β- radiation with strongly differing energies differentiates active roots growing in existing root channels (14C + 137Cs activity) from roots growing in bulk soil (14C activity only).

The feasibility of the approach was shown in a pot experiment with ten plants of two species, Cichorium intybus L., and Medicago sativa L. The same plants were each labelled with 100 kBq of 137CsCl and after one week with 500 kBq of $14CO_2$. 96 h later pots were cut horizontally at 6 cm depth. After the first 137Cs + 14C imaging of the cut surface, imaging was repeated with three layers of plastic film between the cut surface and the plate for complete shielding of 14C β- radiation to the background level, producing an image of the 137Cs distribution. Subtracting the second image from the first gave the 14C image.

Both species allocated 18 – 22% of the 137Cs and about 30 – 40% of 14C activity below ground. Intensities far above the detection limit suggest that this approach is applicable to map the root system by 137Cs and to obtain root size distributions through image processing. The rhizosphere boundary was defined by the point at which rhizodeposited 14C activity declined to 5% of the activity of the root centre. Medicago showed 25% smaller rhizosphere extension than Cichorium, demonstrating that plant-specific rhizodeposition patterns can be distinguished.

Our new approach is appropriate to visualise processes and hotspots on multiple scales: Heterogeneous rhizodeposition, as well as size and counts of roots and biopores formed by these in various soil depths can be determined. Finally, biopore reuse in crop rotations can be visualised.