



Analysis and modelling of transfer processes to plants by foliar pathway of radionuclides in particle form

Zeinab Mawassy, Pascale Henner, Severine Le Dizes-Maurel, Jérôme Rose

► To cite this version:

Zeinab Mawassy, Pascale Henner, Severine Le Dizes-Maurel, Jérôme Rose. Analysis and modelling of transfer processes to plants by foliar pathway of radionuclides in particle form. 28ème Congrès des Doctorants en Sciences de l'Environnement, EDSE, Apr 2021, Marseille (on line), France. irsn-04065133

HAL Id: irsn-04065133

<https://irsn.hal.science/irsn-04065133>

Submitted on 11 Apr 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial - NoDerivatives 4.0 International License

ANALYSIS AND MODELLING OF TRANSFER PROCESSES TO PLANTS BY FOLIAR PATHWAY OF RADIONUCLIDES IN PARTICLE FORM

#poster

Z. Mawassy^{1*}, P. Henner¹, S. Le Dizès-Maurel¹, J. Rose²

(1) IRSN, PSE-ENV/SRTE, Laboratoire de recherche sur les transferts de radionucléides dans les écosystèmes terrestres (LR2T), Cadarache, Bâtiment 183, BP 3, 13115 Saint-Paul-Lez-Durance Cedex, France

(2) Centre Européen de Recherche et d'Enseignement des Géosciences de l'Environnement (CEREGE), Bâtiment Pasteur, Europole Méditerranéen de l'Arbois BP80, 13545 Aix-en-Provence cedex 4, France

* zeinab.mawassy@irsn.fr

Following normal/incidental releases of nuclear facilities, radionuclides may be released into the atmosphere under different speciations (gaseous, particulate, dissolved in water), then be intercepted and possibly retained by plant foliage and translocated to other organs. In the upcoming years, new release scenarios (ITER, UNGG dismantlement) potentially involving particles will be evaluated, thus increasing the need to assess/ improve the existing tools describing transfers of particles and dosimetric evaluation. Knowledge on foliar transfer is still limited and operational tools do not consider the particulate form leading to possible dose underestimation [1]. So, this PhD work aims at quantifying and modelling the key processes influencing particulate radionuclide transfers to plants by foliar pathway.

Particles covers a wide range of scenarios depending on their nature, size and reactivity [2, 3]. At leaf interface, radionuclides may be incorporated by stomatal or cuticular pathways, then possibly reaching conductive tissues [4, 5, 6, 7]. The extent of these processes will depend on the possible dissolution of particles on/within foliage, or intact particles transfer. Yet the conditions (particle size?, reactivity) and mechanisms for intact particles transfer are unknown, thus requiring investigation of both incorporation pathways in relation to particle properties [8, 9]. The resulting radionuclide stocks and fluxes have to be quantified and compared to non-particulate source terms and finally, models need to be tested and/or specifically parametrized and/or completed to allow global assessment of foliar transfer whatever the transfer pathways.

To address these different questions, the project will consist of:

1) Controlled conditions experiments to obtain data on the plant incorporation-leaf absorption through transcuticular/stomatal pathways and translocation as a function of the main following factors: plants characteristics (e.g. foliage interface physico-chemical and morphological criteria: roughness, cuticle thickness, stomatal density and size), particles characteristics (low/high reactive particles with variety of sizes ranging from nano [20-50 nm] to micrometer [$>5 \mu\text{m}$]), or type of deposit (dry/wet). Monitoring of contaminant absorption in/translocation out in leaves will be followed qualitatively/quantitatively by different techniques: e.g. assessing particles locations by 2D and 3D imaging

(SEM-EDX, micro-X-ray fluorescence, micro and nano-Xray tomography).

2) Development and validation of a simple generic model of radionuclides foliar transfer, potentially including specific treatment for low diameter/low reactivity particles. The data obtained from the experiments (see 1) would be compared to aggregated transfer factor predictions and outputs of other generic models related to non-particle source terms. Based on results of comparisons, existing tools will be completed and improved if needed.

3) Numeric application to a real-case scenario (e.g. ITER/ UNGG-like scenario involving tritiated or ^{36}Cl -bearing particles).

Référence

- [1] S. Le Dizès-Maurel, *Review of existing knowledge and data on deposition of airborne micronic (possibly tritiated) particles and subsequent transfer and internalization in plant biomass*, Rapport IRSN n° RT/PSE-ENV/2019-00321, 2019, 40..
- [2] L. Wang, H. Gong, N. Peng, J.Z. Zhang, *Environmental Science & Technology*, 52 (2018) 5182.
- [3] E. Schreck, V. Dappe, G. Sarret, S. Sobanska, D. Nowak, J. Nowak, E.A. Stefaniak, V. Magnin, V. Ranieri, C. Dumat, *Science of the Total Environment*, 476-477 (2014) 667.
- [4] J. Hong, J.R. Peralta-Videa, C. Rico, S. Sahi, M.N. Viveros, J. Bartonjo, L. Zhao, J.L. Gardea-Torresdey, *Environmental Science and Technology*, 48 (2014) 4376.
- [5] C. Larue, H. Castillo-Michel, S. Sobanska, L. Cécillon, S. Bureau, V. Barthès, L. Ouerdane, M. Carrière, G. Sarret, *Journal of Hazardous Materials*, 264 (2014) 98.
- [6] A. Avellan, J. Yun, Y. Zhang, E. Spielman-Sun, J.M. Unrine, J. Thieme, J. Li, E. Lombi, G. Bland, G.V. Lowry, *ACS Nano*, 13 (2019) 5291.
- [7] J. Lv, P. Christie, S. Zhang, *Environmental Science Nano*, 6 (2019) 41.
- [8] P. Hurtevent, Y. Thiry, S. Levchuk, V. Yoschenko, P. Henner, C. Madoz-Escande, E. Leclerc, C. Colle, V. Kashparov, *Journal of Environmental Radioactivity*, 121 (2013) 43.
- [9] P. Henner, P. Hurtevent, Y. Thiry, S. Levchuk, V. Yoschenko, V. Kashparov, *Journal of Environmental Radioactivity*, 124 (2013) 171.