From scientific concepts to standardization: development of a plant-based test for assessing trace element phytoavailability

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ABSTRACT: Recent advances and consensus on the concept of bioavailability must be translated in a set of standardized tools with a hard scientific background to support operationally human and ecological risk assessment in trace element (TE) contaminated soils. These tools are based either on physical-chemical or biological measurements. While the former are usually cheaper and easier to deploy routinely, only the biotests are effective in accounting for the broad range of physiological processes implemented by soil living organisms to regulate TE bioavailability. This is notably true for plants that strongly drive TE phytoavailability in their rhizosphere. Most of, if not all the biotests currently standardized at an international level are focused on the measurement of phytotoxicity. However, as a prerequisite to the assessment of food chain contamination, adequate biotests dedicated to the measurements of TE phytoaccumulation are still lacking.

A plant-based test was initially developed in the past twenty years and used as a research tool to investigate the role of root-induced chemical processes as a driver of TE dynamic in the rhizosphere and TE phytoavailability. This plant-based test was notably characterized by a physical separation between plant roots and soil that enables to collect easily and quickly both compartments separately. This characteristic along with the small size of the system led to evaluate its performance in a few studies as a risk assessment tool. Based on the success of these first applications, the development of the plant-based test, thereafter called the RHIZOtest, reached in the past three years a decisive turning point within the framework of the NormaRHIZO research project.

Built up in four successive steps, the NormaRHIZO project was dedicated to the operationalization of the RHIZOtest tool and methodology in order to achieve an international standardization. The experimental device and procedure were firstly refined to achieve a biotest able to be used as routinely as possible. Secondly, three plant species were selected experimentally to be suggested in the standardized procedure as the reference species. These species (i.e. tomato, cabbage and fescue) belong to three distinct botanical families and exhibit using the RHIZOtest a tendency to over-express TE phytoavailability. Thirdly, the RHIZOtest robustness, repeatability and reproductibility were assessed thanks to an international ring-test. The RHIZOtest was hence validated for the measurement of As, Cd, Co, Cr, Cu, Ni, Pb and Zn phytoavailability. Currently, the scope of the RHIZOtest is evaluated in itself and in comparison with physical-chemical tools conventionally used in risk assessment studies (i.e. soil extractions, DGT and soil solution speciation) through the deployment of each tool on a set of 55 soil samples exhibiting a very broad range of physical-chemical properties.

Armed with this knowledge, a draft describing the RHIZOtest tool and methodology was suggested to the international organization for standardization (ISO). The draft (ISO/CD 16198) has already passed several voting steps, so well that the standard could be definitely published in 2013.