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TXRF analysis of plants' guttation fluids for an expeditious assessment of PTEs uptake from polluted soils

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Guttation is a physiological phenomenon in plants that consists in exudating xylem saps in form of droplets through special foliar structures called hydathodes, mainly located at the tips and the edges of the leaves. Such fluids have been used in the last decades for various purposes, such as for evaluating the plant nutritional status and to assess insecticide residues present in plant crops. Besides, analysis of guttation drops could also provide a non-invasive way for investigating the translocation from roots to shoots of mineral elements, including potentially toxic elements (PTEs), therefore an indirect measure of PTEs uptake from polluted soils. This latter potentiality, however, has been scantly explored.

Within the frame of fast analytical techniques and green sample preparation, total reflection X-ray fluorescence (TXRF) spectrometry is somewhat appealing for elemental analysis of guttation fluid, because of the very low limits of detection (ppb for heavy elements), minimal sample preparation and extremely small quantity of sample required. Indeed, micro-volumes (1-10 µL) are sufficient for liquid samples, i.e. even a single guttation drop can be analysed.

In this study, we used TXRF for the elemental analysis of guttation droplets collected from plants (*Lolium rigidum*) grown in PTEs-polluted mesocosms with the aim of evaluating correlations between PTEs concentration in guttation fluids and their availability in soil in relation to different soil treatments (organic amendments, PGPR). Our results show differences in element translocation: for instance, PTEs like Pb are more concentrated in guttation fluids sampled from plants grown in PGPR treated mesocosms while no Pb was detected in fluids from mesocosms where Pb was almost completely stabilized. These early evidences may suggest this TXRF-based method for the non-invasive, reliable and expeditious assessment of PTEs mobilization from polluted soils and translocation to plants' shoots.