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Assessment of total soil and plant trace elements in rice-based production systems in NE Italy

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Macro- and micronutrients concentrations, and PTEs contents in soils and plants (rice) from the rice district in the Venetian territory (NE Italy) have been determined by ICP-MS spectrometry, with the following aims:
- to determine the background levels of macro- and microelements in the study area;
- to assess possible contamination of soils and plants;
- to calculate the Translocation Factor (TF) of metals from soil to plant, and the possible hazard for human health.
Four rice plots with different rotation systems were investigated from seedling time to harvesting; sampling of soils (0-30cm) and plants was carried out 4 times during growing season (three replicates). Rice plants were separated into roots, stems, leaves and grains, and then oven-dried. Chemical and physical analyses were carried out at the Soil Science Lab of the University of Bologna and Venice, respectively.
The results obtained point to a land with moderate soil contamination by trace elements (namely Li, Sn, Tl, Sr, Ti, Fe). Heavy metal (Sb, As, Be, Cd, Co, Cr, Ni, Pb, Cu, V, Zn) concentrations in soils are below the threshold indicated by the Italian legislation (DM 152/2006). Cd, Sn, and Ti contents in soils are positively correlated with soil pH, while As, Fe, Li, Ti, Tl and Zn are negatively correlated with organic matter content. With the exception of Strontium, soil metal contents are always correlated between variable couples.
HMs in plants vary according to the sampling season, texture and moisture, and soil pH. Most non-essential trace elements are accumulated in rice roots and, only in cases of essential micronutrients, in leaves. Therefore, rice can be assumed as an accumulator plant of As, Pb, Cr, Ba, and Ti, whereas it is as an indicator plant for Cu, Fe, Ni, Mn and Zn. The results of multiple linear regression analysis showed that soil pH has a larger effect on Ba, Cr, Cu, Fe, Mn, Ni, Ti and Zn concentrations in grain than other soil parameters. The average translocation of metals from soil to root was found to be >1, irrespective of the essential/not essential function; conversely, only essential elements ((Cu, Fe, Mn, Zn) are translocated rather easily from roots to leaves (TF $\leq$1) via phloem (TF< <1), and very little translocated to grains (TF< <1).
Therefore, it is suggested that rice could be useful in contaminated-sites restoration projects by the phytostabilization technique. Moreover, there is very limited hazard for human population consuming rice crops.
Key Words: Macro- and micronutrients concentrations, heavy metals, trace elements, rice plant, Italy, accumulator plant, indicator plant
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