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Recycling and biofortification: Hitting two birds with one stone

Chandnee Ramkissoon[1] and Scott Young[2]
[1]University of Adelaide, Australia
[2]University of Nottingham, UK

Currently, about 15% of the global population is consuming inadequate levels of the essential micronutrient selenium (Se) in the diet, which can cause health problems. Applying inorganic Se fertilizers to crops would undoubtedly alleviate the issue but what if there were more natural and sustainable source of Se enrichment? In this study, we hypothesize that recycling sewage sludge as an organic amendment could be just the right economic and environmental Se biofortification strategy. Soil was sampled from the Stoke Bardolph sewage farm, which has a historical sewage sludge fertilization practice. The fate of Se in those soils was determined by (1) liberating total soil Se by aqua regia and (2) fractionating Se in different soil compartments by two extractions: $Ca(NO_3)_2$, which releases soluble Se and KH_2PO_4, which strips off adsorbed Se into soil solution. Speciation of Se was quantified by HPLC-ICPMS analysis. Finally, wheat was grown on the soils to measure and correlate plant uptake of Se. Results showed that the historical application of sewage sludge did indeed enrich the soil with Se. However, only about 1-4% of soil Se has been extracted in this study; the rest of Se in the soil was unaccounted for, possibly due to Se being bound in unavailable organic or mineral complexes. A predominance of soluble organic Se was observed in $Ca(NO_3)_2$ extracts. It also correlated significantly with plant uptake, suggesting that future research should potentially focus on the affinity of plant roots to absorb organic Se from sewage sludge fertilized soils since the redox cycling between organic and inorganic forms of Se is likely to determine the rate of Se uptake by plants. Extractable selenite can also be potential source of available Se for plants, should conditions favor its' desorption from mineral oxides surfaces and hence should be taken into account.

chandnee.ramkissoon@adelaide.edu.au

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