Soil Parameters Influencing Selenium Uptake in Grass Grown Under Field Conditions

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This study was aimed to identify the major soil factors controlling Se bioavailability under field conditions for low Se grassland soils with predominantly organic Se, and to evaluate the effect of NPK fertilization on Se plant uptake in these soils. Field experiments without and with NPK applications were conducted in the Netherlands on 21 and 15 grasslands, respectively. Soil parameters including C:N ratio; selenite content; total Se, S and P in various soil extractions (0.01 M $CaCl_2$, 0.43 M HNO_3, hot water, ammonium oxalate, aqua regia) and DOC in hot water and 0.01M $CaCl_2$ soil extraction, were analysed on soil samples taken from the field without NPK application before the growing season. Selenium content in grass was analysed after harvest. Regression analysis was performed to identify soil parameters determining Se content in grass. Among all the soil parameters measured, Se in hot water extraction correlates most strongly with Se content in grass, which explains about 41% of the Se variability in grass grown under field conditions. This finding indicates that >50% of the Se variability in grass cannot be described by the soil parameters considered in the current study. Selenium in hot water extraction is mostly in organic form, representing the labile organic Se in soils. The content of amorphous Fe-(hydr)oxide and clay in soils has a positive effect on both the amount of Se in hot water extraction and Se in grass, suggesting that adsorption and desorption processes on soil mineral surfaces control the bioavailability of labile organic Se in the soils. Generally, application of NPK fertilizers decreased Se content in grass, especially on organic rich soils. This effect becomes stronger with increasing soil organic matter content, suggesting that interaction between NPK fertilizer and soil organic matter results in a synergetic effect in reducing Se bioavailability in soils. A possible explanation is that NPK application increases soil microbial activity, which reduces Se into a lower valence state that is subsequently immobilized into soil organic matter.

Keywords: Selenium, bioavailability, plant uptake, soil organic matter, NPK fertilization.