Interactions of Silicon and Arsenic in Rice

Limmer, M.A.[1] & Seyfferth, A.L.[1*]
[1]University of Delaware, Department of Plant & Soil Sciences, Newark, DE, USA. angelias@udel.edu

Under flooded cultivation, rice grain accumulates high levels of arsenic, posing a health risk to consumers. Currently, no solutions have been found that can simultaneously minimize As accumulation in grain, maintain grain yield, and limit grain accumulation of other toxic metals. However, silicon (as silicic acid) is a chemical analog of arsenite, the prevalent form of inorganic As in rice paddy porewater. Thus, we investigated the ability of agronomic sources of Si to limit rice accumulation of As. Rice paddy microcosms were amended with three different Si-rich materials (rice husk, charred rice husk, and silicate fertilizer) prior to planting in 2015 and monitored for 3 years. Concentrations of trace metals in the porewater, porewater redox, and methane fluxes were measured weekly throughout each of the growing seasons. At harvest, plants were divided into several plant parts including polished grain, bran, unripe grain, unfilled grain, rachis, nodes, flag leaves, straw, roots, and root iron plaque extracts. The various plant parts were analyzed for elemental composition. Root iron plaques were analyzed for As speciation using XANES and iron mineral composition using EXAFS. Over 3 years, the Si-rich amendments increased plant accumulation of Si and decreased plant accumulation of As. Porewater chemistry was not significantly affected by the amendments in any of the years. Importantly, Si-rich amendments did not affect grain total arsenic but affected the speciation of grain As – increasing organic As and decreasing inorganic As in the grain. Decreasing inorganic As in the grain is beneficial to human health because inorganic As is more toxic than organic As.