Reduced Arsenic Mobility and Bioavailability in Paddy Soil with Iron Based Amendments

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Arsenic (As) contamination in paddy soil is of great public concern in South China where rice is a staple food. Redox cycling of iron is known to control As mobility and bioavailability, and soil amendment with differnt Fe-based products is now a recommentd farming practice for enhancing iron redox reactivity and reducing As uptake by rice. However, it is not known when it is the best time over the entire rice growth stage for intervention that can maximize the cost-benefit with such a practice. This study investigated arsenic mobility and bioavailability in paddy soil amended with different iron constituents over the entire growth stage of rice plant. Pot experiments were conducted using the same soil amended with: 1) amorphous Fe oxide, 2) $FeCl_2$, 3) $FeCl_2$+$NaNO_3$, along with two control soils of 4) the untreated soil (control) and 5) amended with $NaNO_3$. Samples of soil, rice plant (whole plant sample and samples of grain, straw, and root fractions) and Fe plaque on roots were collected at each of the four rice growth stages of tillering, jointing, heading, and maturation stages. The results showed that the whole rice plant at the heading stage had the highest As contents. Significantly positive correlations were found between the concentration of dissolved As in soil at the heading stage and grain As or straw As at the maturation stage, indicating the important contribution of bioavailable As at the heading stage to As uptake in rice plants at the maturation stage. In addition, As transfer coefficient from roots to the rice plant tissues above the ground showed a decreasing trend at the heading stage, indicating a lower translocation of As from roots to shoots at this stage. The study suggested that the heading stage may be the key stage for intervention in order to reduce As uptake by rice. Meanwhile, Fe plaques at the root surface can reduce As mobility and bioavailability by direct adsorption of As. Our data showed that the concentrations of the mobile As in soils were negatively correlated with the As contents in Fe plaques. It appears that application of Fe-based products in soil for reducing As accumulation in rice is a very promising practice.