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Silicon release during rice straw decomposition – a one-year litterbag study in Southeast Asia

Thimo Klotzbücher (1), Anika Klotzbücher (1), Stefan Hotes (2), Doris Vetterlein (3), Florian Schmidt (1), and Robert Mikutta (1)

(1) Martin Luther University Halle-Wittenberg, Institute of Agricultural and Nutritional Sciences, Soil Science and Soil Protection, Germany (thimo.klotzbuecher@landw.uni-halle.de), (2) Philipps-University Marburg, Department of Ecology, Germany, (3) Helmholtz Centre for Environmental Research, Department of Soil System Science, Germany

Recent research demonstrated that silicon (Si) is a beneficial nutrient for rice growth as it enhances the plants′ resistance against abiotic and biotic stresses. The role of rice straw recycling on the biogeochemical Si cycle in paddy fields is, however, hardly studied yet. Here, we conducted one-year litterbag experiments to assess Si losses from rice straw during decomposition in dependence on (i) location of straw in the soil, (ii) activity of mesofauna, and (iii) ambient Si availability in the soils.

Our study regions were located in the Mekong Delta in Southern Vietnam, where Si availability in soils is generally low, and on the Philippine island Luzon, where Si availability is high. We studied three paddy fields per region. Rice straw from the Philippines (C/N=42; 7.8 % Si) was filled into litterbags of two mesh sizes: 20μm*20μm (no access for mesofauna) and 5000μm*5000μm (with access). Litterbags were placed either above the soil surface or within the topsoil horizon of the paddy fields. Litterbags were retrieved from the fields after 4, 12, 25, and 52 weeks (three replicates each).

During 52 weeks, the rice straw mass loss was in average 88 $\pm$ 6 %. The mass loss rates decreased over time and were only slightly, but not significantly increased by mesofauna. Also the location of straw on the surface or in the soil did not significantly affect mass loss rates after 52 weeks of decomposition. Significant differences in Si release rates were only found between the study regions. At the Philippine sites, the straw Si concentrations increased over time (from 7.8 % to 11.6 $\pm$ 2.3 % during 52 weeks), while they slightly decreased at Vietnamese sites (6.6 $\pm$ 0.5 % after 52 weeks). We assume that these differences are driven by ambient Si concentrations in soil solutions, i.e. at higher Si concentrations (Philippines) the dissolution of phytoliths (=amorphous Si oxide bodies in straw) should be reduced.

Overall our data demonstrate that Si loss from rice straw during decomposition is fast, hence, allowing rice straw to decompose in situ should be an important factor driving the Si fluxes and plant Si availability in paddy topsoils. In particular in regions with low Si availability (e.g., regions with old and weathered soils), farmers should consider leaving the straw on the fields.