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Water uptake depth analyses using stable water isotopes in rice-based cropping systems in Southeastern Asia

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Rice is one of the most water-consuming crop in the world. Understanding water source utilization of rice-based cropping systems will help to improve water use efficiency (WUE) in paddy management. The objectives of our study were to (1) determine the contributions of various water sources to plant growth in diversified rice-based production systems (wet rice, aerobic rice) (2) investigate water uptake depths at different maturity periods during wet and dry conditions, and (3) calculate WUE of the cropping systems.
Our field experiment is based on changes of stable water isotope concentrations in the soil-plant-atmosphere continuum due to transpiration and evaporation. Soil samples were collected together with root sampling from nine different depths under vegetative, reproductive, and matured periods of plant growth together with stem samples. Soil and plant samples were extracted by cryogenic vacuum extraction. Groundwater, surface water, rain, and irrigation water were sampled weekly. All water samples were analyzed for hydrogen and oxygen isotope ratios (δ2H and δ18O) via a laser spectroscope (Los Gatos DLT100).
The direct inference approach, which is based on comparing isotopic compositions between plant stem water and soil water, were used to determine water sources taken up by plant. Multiple-source mass balance assessment can provide the estimated range of potential contributions of water from each soil depth to root water uptake of a crop. These estimations were used to determine the proportion of water from upper soil horizons and deep horizons for rice in different maturity periods during wet and dry seasons.
Shallow soil water has the higher evaporation than from deeper soil water where the highest evaporation effect is at 5 cm depth (drying front). Water uptake is mostly taking place from surface water in the vegetative and between 5-10 cm in the reproductive period, since roots have grown widely and deeper in the reproductive stage.
This will be helpful to understand the WUE and identify the most efficient water management system and the influence of groundwater and surface water during both seasons in rice-based cropping ecosystems by using means of stable water isotope.