

ABSTRACT

The effect of alternative irrigation management on micronutrient availability and GHG emissions in paddy soils

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In a context of increasing food demands and a changing climate causing decreased water availability, alternative irrigation management (AIM) in paddy rice production is broadly being applied in Asia and other rice producing regions. In combination with efficient soil fertilization management, AIM aims at sustainably intensifying rice production while using less water. However, AIM's increasing popularity may impose a trade-off from saving water to increasing GHG emissions (mainly of N₂O) and affecting micronutrient availability in paddy soils. The general objective of this research was to assess the effect of AIM on micronutrient availability (Fe, Mn, Cu and Zn), GHG emissions and other relevant related soil and plant parameters.

Soils from the plough layer of 3 Philippine farmers' paddy fields with differing soil textures were collected for a greenhouse pot experiment. The samples were subjected to three commonly applied irrigation techniques, differing in the number and duration of draining events along the growing season: continuous flooding (CF), alternate wetting and drying (AWD) and mid-season drainage (MSD). Micronutrient availability to plants (DTPA extracts), GHG emissions (CH₄, CO₂ and N₂O) and various biogeochemical parameters such as exchangeable NH₄, dissolved OC (DOC), pH and soil redox potential and temperature were assessed during the entire growing season. Other plant related parameters (plant height, tiller and leaf number and mean biomass) were measured during harvest.

Results indicate a reduced availability of Fe and Mn under an AWD compared to CF regime, particularly during the reproductive growth phase of the rice plants. During the earlier growth stages, however, Cu and Zn concentrations show an opposite trend for all soil types. As for mineral nitrogen concentrations, a strong decline was observed for all three soil types, regardless of the water management applied. By the end of the ripening stage, contents close to zero kg ha⁻¹ were generally observed, probably due to enhanced volatilization of NH₃ towards the end of the growing season, caused by the high ambient temperatures in the greenhouse. DOC concentrations did not show clear differences between any of the treatments. CH₄ fluxes were surprisingly high at the onset of the growing season but they quickly declined within a time span of three weeks. Due to considerably low CH₄ emission values during the rest of the growing season (not exceeding 10 mg m⁻² d⁻¹), no significant differences could be observed between the three irrigation treatments. Analyses of measured N₂O and CO₂ emissions are still in progress. Rice plant height, tiller and leaf number and mean biomass were all favored by CF when compared to AWD management in all three soils.

The above mentioned results indicate that while water saving management in rice farming reduces emissions of CH₄, it may as well limit micronutrient availability for rice plant uptake, and in our pot experiment also crop growth.