ABSTRACT

Alternate wetting and drying (AWD) irrigation practice in rice cultivation can save a significant amount of irrigation water. This practice involves irrigating rice fields alternately based on a triggering criterion and possibly it affects water flow and nutrient dynamics within the soil-plant-water system. The challenges in AWD practice include lack of understanding on the effect of AWD on water and nutrient balance, crop growth and yield, gross revenue and on an appropriate irrigation-triggering mechanism that can save water significantly and control water and nutrient losses without reducing the yield. In this study, the soil matric potential head (SMPH)-based irrigation, a kind of AWD method, was studied to address the above-mentioned challenges using field and simulation studies.

Field studies were carried out using the non-weighing lysimeters facility of Agricultural and Food Engineering Department by cultivating a rice crop during the rabi seasons of 2014-15, 2015-16 and 2016-17. Three levels of SMPH (no soil water stress-conventional irrigation: NS, mild soil water stress/400 cm: MS and severe soil water stress/750 cm: SS) were considered along with three nitrogen levels (high nitrogen: HN/150 kg N/ha; medium nitrogen: MN/120 kg N/ha; low nitrogen: LN/60 kg N/ha) and they were replicated three times. During the experimentation, the daily ponding water depth and SMPH at 10, 40 and 70 cm soil depths were measured. The agronomical parameters (plant height, number of tillers, biomass and grain yield) and nutrients' (nitrogen, phosphorus and potassium) concentration for ponding water, and the soil water at 10, 40 and 70 cm soil depths were measured at selected intervals. The field experimental data were used to assess water and nutrients dynamics, determine the crop production function and gross revenue and simulate water flow and nutrient transport with the help of the Hydrus-1D model. Finally, the appropriate irrigation and nutrient management practice was selected based on the simulations of Hydrus model and the results of Design of Experts software.

It was found that the grain yield under MS was almost similar to NS, but it was reduced by 9% under SS. The net profit was estimated to be doubled for MS practice compared to the current farmers' practice. The Hydrus-1D model was able to simulate water flow and nutrients transport for SMPH-based rice irrigation. The MS and SS practices reduced 23 and 27% total available water depth, 12 and 18% seasonal crop evapotranspiration and 29 and 34% of deep percolation, 6 and 15% N uptake, 5 and 15% of P uptake, 7-18% of K uptake, 38 and 52% N leaching, respectively compared to NS. Both volatilization and denitrification losses were increased by 14 and 7% in MS, and 17 and 7% in SS, respectively when compared to NS. The depth of irrigation of 4.5 cm with the recommended dose of fertilizer (N: P: K- 120: 50: 60 kg/ha) and SMPH of 400 cm was considered as an appropriate irrigation and nutrient management practice, which resulted a maximum grain yield of 5 t/ha and net profit of Rs.20595. If this method is practiced, about 230-310 billion liters (39-45%) of the water supply from Kangsabati reservoir can be saved hypothetically and utilized for cultivating additional crops in the command area.

Keywords: *Water flow, nutrient transport, alternate wetting and drying, water and nutrient use efficiency, Hydrus-1D, paddy, water and nutrient balance, crop production function, gross margin revenue.*