Abstract

In an attempt to maximize water and nitrogen (N) use efficiencies of rice-wheat system in the Red and laterite agro-climatic zone of West Bengal, India by selecting the most suitable combination of agro-management practices, a comprehensive investigation comprising field and laboratory experiments as well as modelling study, was conducted in a acid lateritic sandy loam soil (Haplustalf) at the Indian Institute of Technology, Kharagpur. The main goal of the investigation is to evaluate the effects of tillage depth, liming, soil moisture regime, application of polymer coated urea and split application of N on water and N dynamics under rice and wheat crops, assess the transformation processes of coated and uncoated urea in relation to liming, soil moisture regime, form and split application of urea, and quantify the effects of agro-management practices on yield, water and N use efficiencies of rice and wheat crops. The laboratory experiment was conducted to study the processes of hydrolysis and transformation of urea in relation to liming, moisture regime, form and split application of urea. The fluxes of water and NO_3-N below root zone of rice and wheat crops were simulated with the help of Root Zone Water Quality Model (RZWQM). Wetland rice and irrigated wheat were grown in sequence respectively during monsoon and post-monsoon winter seasons of 1999 – 2000 and 2000 – 2001 with fertilizer N applied @ 100 kg N ha^{-1}.

The results of the investigation indicate that the deep percolation loss can be effectively reduced by shallow puddling and liming of soil under rice crop and by adopting dry soil moisture regime (3.6 cm irrigation applied at 0.6 IW/CPE) in the limed soil under wheat crop. Application of polymer coated urea in two or four splits help reduces the rate of transformation of urea and volatilization loss of NH_3. The leaching losses of water soluble N can be significantly reduced by four split application of polymer coated urea and by adopting deep puddling and rainfed soil moisture regime for rice crop, as well as by shallow tillage and dry moisture regime for wheat crop. The maximum recovery of N by rice-wheat system can be attained by applying lime @ 1.5 t ha^{-1} in combination with deep puddling for rice and deep tillage for wheat, continuous flooding for rice and wet soil moisture regime (6 cm irrigation applied at 1.0 IW/CPE) for wheat and four split application of polymer coated urea to both the crops. The combination of liming, deep puddling for rice and deep tillage for wheat, continuous flooding for rice and wet soil moisture regime for wheat and four split application of polymer coated urea is the best combination of agro-management practices for maximum grain yield of rice and wheat crops. The water flux below root zone of rice crop, soil moisture distribution under wheat crop and NO_3-N flux below root zone of both rice and wheat crops are reasonably predicted by the RZWQM model. The matching between simulated and measured fluxes of NO_3-N was closest with four split application of urea under relatively dry soil moisture regime. Low values of Standard Error, Relative Error and Root Mean Square Error and high value of Nash-Sutcliffe Simulation Efficiency reflect to high predictability of RZWQM for soil moisture distribution under wheat crop as well as water and NO_3-N fluxes below root zone of rice crop.