Paddy Water Environ
DOI 10.1007/s10333-014-0439-x

ARTICLE

Prediction of root zone water and nitrogen balance in an irrigated rice field using a simulation model

Ch. Jyotiprava Dash · A. Sarangi · D. K. Singh · A. K. Singh · Partha Pratim Adhikary

Received: 1 February 2012 / Revised: 10 October 2013 / Accepted: 15 April 2014

Abstract In irrigated semi-arid regions, knowledge of groundwater recharge and nitrate leaching is essential for sustainable management of water resources. In this study, the potential recharge and nitrate leaching below the root zone of rice crop were estimated using a root zone modelling approach through simulation with HYDRUS-1D model. The field data collected for a single season were used for calibrating the model and validated for the next season. The simulated results, when compared with the measured soil water and nitrate contents at different soil depths showed good agreement between the HYDRUS-1D simulation and field data. The validated results indicated that 55.5 % of the applied water percolated below the root zone. Nitrogen balance within 120 cm deep soil profile indicated that volatilization, denitrification, plant uptake and leaching losses were 24.0, 18.9, 109.0 and 28.5 kg N ha^{-1}, respectively. The magnitude of nitrate leaching was 23.7 % of added fertilizer. Different nitrate leaching scenarios were generated using different fertilizer application rates exceeding the optimal dose. These scenarios showed an increasing trend with increase of fertilizer rates, fitted with a second-order polynomial equation ($R^2 = 0.99$). The equation can be used for estimation of nitrate leaching below root zone under different fertilizer input scenarios of rice grown in similar hydro-agro-climatic regions.

Keywords Rice · Nitrate leaching · Groundwater · HYDRUS-1D · Fertilizer use scenario

Introduction

Like many other Asian countries, rice is the main staple food in India. Over the last decade, the compound growth rate of rice production is 1.78 % (Economic Survey of India 2011–2012), as against the decadal population growth rate of 17.64 % (Census 2011). These two growth anomalies necessitate the requirement of huge additional quantity of rice. Further, the gradual decrease of cultivable area hinders the horizontal growth of rice production leaving the only option of vertical growth. Among the various production maximization factors, the most impor-