Abstract

Disposal of nitrate from agricultural lands is one of the most important diffuse sources of pollutants loads to natural aquifers While nitrogen is one of the most important nutrients in completing plant growth cycle, unmanaged fertilization with rates higher that crop N requirement results in surplus-N leached into the groundwater resources through irrigation of precipitation, which consequently threaten environmental sustainability within a region. This is a more significant case under dry farming due to unexpected precipitation, and sometimes, higher than crop water requirement. In addition, global warming may affect nitrate leaching due to the imposed change into climatic and crop properties. Hence, in this research, the optimal N fertilization rate was determined for rained maize in Mazandaran province under current and future climate. Using the output of 20 GCMs under three RCPs scenario (i.e., RCP2.6, RCP4.5 and RCP8.5), weather data were downscaled in four synoptic stations in the study area for three 3.-year time periods up to 2100. Thereafter, the calibrated and validated HYDRUS2D model was applied to simulate N dynamics under 9 fertilization scenarios, either for the current or for the future period. The model was calibrated and validated based on data collected during two growing seasons of maize in the study area. Finally, optimal N-fertilization rates were obtained based on N-fertilizer use efficiency (NUE) and the ratio of crop yield to N-fertilization rate were applied (TE). Based on the criteria indices, the HYDRUS2D model was capable enough for simulating soil water content (RMSE=0.8-1.18 mm), soil NO_3 content (RMSE=0.38-7.95 mg l^{-1}), and crop N uptake (RMSE=3.96-8.96 kg ha^{-1}). Under current condition, Based on the simulated results for the current condition, N uptake will increased by 20 kg ha^{-1} on average in response to every 50 kg ha^{-1} increase in N fertilization rate beyond 200 kg ha^{-1}. N leaching below different soil depths increased along with reduced crop N uptake, which led to nutrient removal from the surface soil layers and its aggregation in underlying soil layers at the end of the growing season. Fertilizer use efficiency had its highest value at fertilization rate of 150 kg ha^{-1}, while it remained unchanged at higher N rates. Nevertheless, increased N rate always lead to yield reduction per unit applied fertilizer. For mid 21th century, FUEs were in the range of 24.2-42.9 percentage, which were 7-8% higher than those obtained for the base period. While global warming exposed a 14.5-16.6% increase in nitrate leaching,

increased FUE may be attributed to a 4.7-9.9% increase in crop N uptake under future climate. However, TEs vary in the range of 0.3-1.3 kg m^3 during mid 21^{th} century, which were nearly the same as those for the base period. Based on the results, it may be concluded that adjusting N-fertilization rates may have a substantial role in achieving sustainable rainfed cropping in the study area under global warming.

Key words: Climate Change, Nitrate Losses, Numerical Simulation, Fertilization Rate.

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Application of HYDRUS-2D for Assessing the Influence of Fertilization Management on Alleviating the Risk of Nitrate Leaching under the Occurrence of Global Warming during Maize Winter Cropping

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