Relationship between Denitrification Rate and Infiltration Rate in Ponded Soil

Satoko Watanabe[1]; Kimihito Nakamura[1]; Shigeto Kawashima[1]

[1] Environmental Science and Technology, Kyoto Univ.

Control of the soil infiltration rate by changing the groundwater level in agricultural fields is expected to increase the residence time of infiltrated water in soil. This, in turn, increases root uptake of nutrients and the amount of denitrification and avoids environmental degradation induced by excessive nitrogen outflow. We performed a laboratory experiment to investigate the effect of the infiltration rate on the amount of denitrification. Paddy soils were packed in soil columns (inside diameter, 10.5 cm; length, 40 cm) and then saturated by ponding. A different infiltration rate was produced in each soil column by setting a different hydraulic gradient. The nitrate potassium solution was applied to the soil surface continuously during the experimental period under the condition of ponding, and methanol, which is a hydrogen donor and carbon source for denitrification, was applied additionally from day 8 after the start of the experiment until the end. Concentrations of cations and anions, including nitrate, in leachate and soil solution from three depths were measured. The ratio of denitrification to nitrate-nitrogen input decreased linearly with increasing infiltration rate from 100 to 450 mm/day under the soil condition limited by methanol. Under the methanol-rich condition, the denitrification rate was not controlled by the infiltration rate at an infiltration rate below 200 mm/day. These findings indicate that the relationship between denitrification rate and infiltration rate depend on the amount of carbon in the soil. For estimation of the result quantitatively, with regarding denitrification reaction as a first-order reaction based on chemical kinetics, the first-order reaction rate constants for the denitrification rates in the 4 days while carbon sources was limited were determined by the inverse analysis using the convection-dispersion equation for nitrate transport in ponded soil. The relationship between the first-order reaction rate constant and infiltration rate was estimated. As a result, it was showed that there was a negative correlation between them. Under the methanol-rich condition, any clear relationship was not obtained because application of substantial carbon source decreased the infiltration rates of different columns to the same level probably due to soil pore clogging. It is possible to control the soil infiltration rate artificially through the groundwater level management to increase denitrification rate in ponded soil except under the rich carbon source condition.