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Phosphorus adsorption dynamics and retention capacity in agriculture drainage ditch sediments

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NGUYEN, Van Huy[1*] ; MAEDA, Morihiro[1]
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[1]Graduate School of Environmental and Life Science, Okayama University, 3-1-1, Tsushima-Naka, Kita-Ku
[1]Graduate School of Environmental and Life Science, Okayama University, 3-1-1, Tsushima-Naka, Kita-Ku

A number of interactions occur between ditch sediment and overlaying water, in which P adsorption is a major process in controlling soluble P concentration in water. Drainage ditches in Kasaoka reclaimed land, Japan is under alkaline conditions (pH >8), because drainage water is diluted with seawater. Our surveys have also demonstrated that ditches were contaminated with high concentration of phosphorus (P). Sediment has a vital role in removing P from discharge water by adsorption. Previous studies have reported sediment P retention capacity under acidic conditions, but little information on phosphorus retention capacity under alkaline conditions was reported. This study aims to evaluate P equilibrium between ditch sediment and overlaying water, and P retention capacity of sediment by determining adsorption parameters under alkaline conditions. Three sub-experiments were carried out in order: (1) adsorption kinetic measurement; (2) adsorption at ambient water P for zero equilibrium P concentration (EPC_0) and P buffering capacity estimation; and (3) sediment P retention capacity determination by using the Langmuir model. Surface sediment (0-10 cm) and overlaying water were collected in three drainage ditches, which receive drainage water from livestock-horticulture area (LHA), livestock area (LA) and grassland area (GLA). In addition, sediment core layers (0-2, 2-4, 4-6, 6-8, 8-10 cm) were taken for evaluation of pore water P concentrations. Results showed that pore-water P of LA and LHA increased with increasing the depth layers, whist GLA sediment decreased. Sediment particle sizes showed a two-third proportion of silt contents. The kinetic adsorption of sediments consisted of two stages that were quick and slow stages regardless of sites. The quick stage was within the first hour of incubation, and slow stage afterward. The LA drainage ditch, which was more contaminated with P, was the highest the sediment EPC_0, followed by LHA, and GLA ditches. The sediment EPC_0 indicated that three ditch sediments act as a sink for P across sediment surface. The Langmuir models were fitted well with experimental data and adequately describe adsorption isotherms of sediments in this study (r^2 >0.95). Phosphorus retention capacity of sediments by maximum adsorption calculations ranged from 384.2-416.7 mg kg^{-1}, binding energy (K) (0.195-0.263 L mg^{-1}). Our results indicate the importance of ditch sediment in controlling P dynamics discharged from agricultural farms.

キーワード: adsorption, Agricultural drainage ditches, sediment, phosphorus, retention capacity
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