Adsorption-Desorption Behavior of 2,4-Dichlorophenoxyacetic Acid in a Volcanic Ash Soil

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Adsorption and desorption are key processes governing fate and transport of pesticides in soil-water system. A better understanding of those processes can be helpful for providing essential information on the mobility of pesticides and their distribution in soil. Among widely used pesticides, 2,4-dichlorophenoxyacetic acid (2,4-D) is an oldest and well known herbicide because of its good selectivity and inexpensive cost. Despite much work being carried out on 2,4-D adsorption onto soils, only few studies of 2,4-D adsorption have been focused on volcanic ash soils. Furthermore, the knowledge of 2,4-D desorption from volcanic ash soils is still limited. In this study, adsorption-desorption behavior of 2,4-D in a volcanic ash soil sampled from Nishi-Tokyo, Japan was investigated under different pH conditions.

Batch adsorption and desorption experiments were carried out with three concentrations of 2,4-D (2.5, 5, and 10mg/L) under three pH conditions (natural pH, 5.0, 4.0) in triplicate. 2,4-D solutions were prepared in artificial rain water (ARW= 0.085mM NaCl + 0.015mM CaCl2) to simulate field conditions. The samples were prepared by adding 10mL of 2,4-D solution into 1g of the soil. Consecutive desorption was repeated three times during an equilibration procedure to obtain a desorption isotherm.

The results showed that both adsorption and desorption isotherms were well fitted with the Freundlich isotherm model. Measured adsorption coefficients have negative correlations with pH of soil solutions. Hysteresis (or irreversibility) in the adsorption-desorption process was found at each concentration and pH condition. The irreversibility of adsorption was quantified by hysteresis index. The degree of irreversibility was enhanced under the lower pH condition, and the highest value of hysteresis index (the lowest desorption) was obtained at pH 4.0. This strongly suggests that the irreversible reaction (e.g., ligand exchange) was a possible dominant mechanism of 2,4-D adsorption onto volcanic ash soil, especially at low pH condition.