学　位　論　文　要　旨

Fate and transport of herbicides in andisol soil considering temperature dependency of adsorption and degradation processes: in case of atrazine and metolachlor

黒ボク土壌における除草剤の吸着・分解の温度依存性を考慮した動態に関する研究　－アトラジンとメトラクロールを事例に－

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The widespread use of herbicides such as atrazine and metolachlor in agricultural cultivation has been often resulted in contamination on surface and ground waters, and soils in the environment. Environmental monitoring and modelling are the viable means of assessing the pesticide risks in the environment. However, a comprehensive investigation consisting of a series of agricultural field and laboratory experiments, and model simulations to assess environmental behavior of such herbicides has not been carried out in Japan.

The major objective of this research is thus to investigate the fate and transport of two herbicides, atrazine, and metolachlor in andisol soil considering temperature dependency of adsorption and degradation processes through the field monitoring, laboratory experiments and numerical model simulations. The specific objectives to accomplish the major objective are; 1) to monitor the behavior of two herbicides in the field during two different crop seasons 2) to investigate of degradation processes of test herbicides in andisol soil using batch experiments under different temperature, 3) to investigate of leaching processes of both herbicides using column experiments in agricultural soil, and 4) to conduct numerical simulation and evaluate the fate of test herbicides in agricultural soil.

Firstly, the environmental behavior of two herbicides in under summer season and winter season in agricultural soil at an experimental field, Fuchu, Tokyo, under natural weather condition was conducted to investigate the

effects of environmental conditions such as temperature, precipitation and soil moisture. In this study, the concentration of two herbicides declined exponentially with time and the dissipation half-lives of atrazine and metolachlor were 16 days, 32.7 days, and 23.5 days, 51.8 days, respectively in summer and winter season. However, the influence of temperature on herbicides fate during summer and winter in the agricultural field was difficult to assess due to combined effects of multiple factors.

Secondly, the batch experiments for herbicide degradation and equilibrium soil/water partitioning under different temperatures of 5, 20 and 35^{o}C were conducted, to investigate the effects of temperature variation on the behavior of these herbicides during the summer and winter seasons. As the results, the degradation of atrazine and metolachlor in agricultural soil was increased by temperature. However, no significant difference was observed in equilibrium soil/water partitioning of herbicide on andisol soil.

Thirdly, the leaching experiment of both herbicides was conducted using soil column with prescribed hydrological conditions under room temperatures. The soil samples were prepared same as above and they were packed into a 35 cm long soil column. The great amount of both herbicides were found in surface soil and appreciable herbicide concentrations in leachate was also detected.

Fourthly, numerical model, SPEC, predicted environmental concentrations of target herbicides in agricultural soils under prescribed environmental conditions. For the statistical evaluation, the simulated herbicide concentrations by SPEC model indicated accurate prediction of the observed data as the NSE values (0.33 for atrazine and 0.26 for metolachlor) were closer to 0.

In conclusion, this study investigated the fate mechanisms of two herbicides, atrazine, and metolachlor, in the agricultural soil. The field dissipation of two herbicides was faster in summer season as compared to the winter season and the fate of herbicide was affected by the hydrological conditions and other environmental conditions. The degradation of atrazine and metolachlor in andisol soil was increased by temperature, however no significant effect of temperature was observed in equilibrium soil/water partitioning of herbicides. For the leaching experiment of both herbicides, the appreciable concentrations in the surface soil in soil column and leachate were detected. Model prediction of herbicide concentrations in monitored field was accurate and the model has potential to apply for the environmental assessment of pesticide in agricultural soil.