Evaluation of ecological risk assessment of nursery box applied insecticide via uncertainty inputs in rice paddy

Kei Kondo[1]*, Dang Quoc Thuy[1], Hiroshi Sakai[1], Dang Quoc Thuyet[1], Hirozumi Watanabe[1]

[1]Tokyo Univ. of Agric. and Tech.

Rice paddy fields share about 55% of total farm land in Japan. Nearly 40% of total domestic pesticides such as herbicide and insecticide have been applied for stable productivity and labor saving in paddy fields. In the process of paddy rice cultivation, application of insecticide to nursery box plays an important role on preventing young rice seedling from being damaged by insects. Meanwhile, its toxic mode of action of insecticide can also affect other species living in rice paddy environment. The objective of this study was therefore to assess the environmental risk of insecticide application using process-based model under the various uncertainty condition of insecticide fate and transport processes through stochastic approach.

PCPF-1 model (Pesticide Concentration in Paddy Field type-1), which predicts pesticide concentrations in paddy water and top 1 cm surface paddy soil compartments, was used. Fipronil was chosen as the target insecticide. Input parameters of deterministic simulation of fipronil were calibrated by the results of field and laboratory experiments. Considering various responses in fipronil fate and transport processes, uncertainty analysis incorporating Monte Carlo techniques was carried out by characterizing input parameters using probability density functions for both physicochemical parameters and water management parameters with different practices and regions. Simulation results were rearranged as exposure concentration distribution (ECD) expressed as exceedance function for both paddy water and surface paddy soil. Next, species sensitivity to the toxicity of fipronil was described by species sensitivity distribution (SSD) using literature values of median effective concentration (EC50) and median lethal concentration (LC50). Since lognormal distribution is widely used to express the SSD, literature values were fitted into lognormal distribution using goodness of fitting test. Effect of fipronil exposure on aquatic biota was evaluated by overlapping ECD and SSD. Ecological risk of fipronil was estimated as probability of failure which indicates the proportion of species.

This study showed that aforementioned evaluation method was applicable for ecological risk assessment of nursery box applied insecticide. Furthermore, by coupling other models, ecological risk assessment can be extended for vadose zone and ground water in both on-farm plot and regional scale.

Keywords: Rice paddy, insecticide, process-based model, ecological risk, species sensitivity distribution, uncertainty analysis