Application of the PCPF-F model for simulating pesticide fate and transport under foliage application

PCPF-F モデルを用いた葉面散布における農薬動態予測への適用について

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1. Introduction

By far, the most frequently used pesticide application method is spraying by mixing pesticide with water and then applying on plant (Sarwar, 2015). Previous studies have reported that under this type of application the efficacy of applied pesticide can be reduced by rainfall due to the washing the foliage-applied compounds off the plant (Reddy et al., 1994). That might also cause more risk of pesticide contamination to environment by increasing the availability of pesticide for runoff. In order to evaluate the risk of pesticide to environment, the fate and transport of pesticide under the application need to be regularly monitored. While an experiment is difficult with labor and time-consuming, computer model has been an advantageous alternative management tool for environmental risk evaluation in recent years. Therefore, the objective of the study is to predict the pesticide fate and transport under foliage application by using a computer model.

2. Material and method

The study applied Pesticide Concentration in Paddy Field - Foliage application (PCPF-F) model which is an updated version of Pesticide Concentration in Paddy Field (PCPF-1) model. The input data for applying the model were mainly collected from a previous study. All details regarding to the study's experiment, procedures for sampling and chemical analyses can be found elsewhere (Phong et al., 2008). Briefly, the study aimed to investigate the behavior of fungicide, tricyclazole ($C_9H_7N_3S$) wash-off in rice lysimeters. The experiment was conducted under micro portable rainfall simulator with rainfall intensity of 30 mm h^{-1}. The initial pesticide concentration just after fungicide sprayed and wash-off concentrations after two rainfall simulator events were analyzed. In addition, the model input parameters were calibrated by utilized the Sequential Uncertainty Fitting version 2 (SUFI-2) algorithm (Abbaspour et al., 2007).

3. Results and discussion

The model input parameters were calibrated, and the Nash-Sutcliffe model efficiency coefficient (NSE) value increased from 0.73, 0.44 to 0.85, 0.97 for concentration of tricyclazole in the wash-off water and the paddy water after spraying, respectively. The concentration of tricyclazole in the wash-off water after rainfall simulators were given in figure 1. In general, the wash-off concentrations of tricyclazole ranged from 28.01 to 119.26 ug L^{-1} which were comparable to the measured concentration of the experiment. In the both rainfall events, simulated concentrations of tricyclazole in wash-off water of set 1 was higher than that of set 2 while wash-off concentration in set 3 was significantly lower than those in two other sets. The application rate, application efficiency and leaf area index as well as degradation process could be probably explained for the differences among sets. After the first rainfall events, a small amount of

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tricyclazole was washed off from leaf surface in the second rainfall. While the simulated and measured concentration were very high agreement in the first rainfall events, there were differences between them in second simulator rainfall events. The simulated concentrations were 2.1 to 3.5 times higher than those of the measured data. That might because of the missing process in the model assumption, uncertainty of model input parameters and experimental errors.

For the concentration of tricyclazole in paddy water after spraying, the simulated concentrations were 106.29, 49.32, 27.75 ug L^{-1} for set 1, set 2 and set 3, respectively. Meanwhile, the measured concentrations were 100 ug L^{-1}, 55.6 ug L^{-1} and 26.7 ug L^{-1} for set 1, set 2 and set 3. Figure 2 shows the simulated and measured concentrations of tricyclazole in paddy water after spraying and illustrates that they were in approximately level. The NSE value indicated that the simulated concentrations were very good and the model algorithm which used for calculating the initial concentration of pesticide in paddy water after spraying was satisfactory.

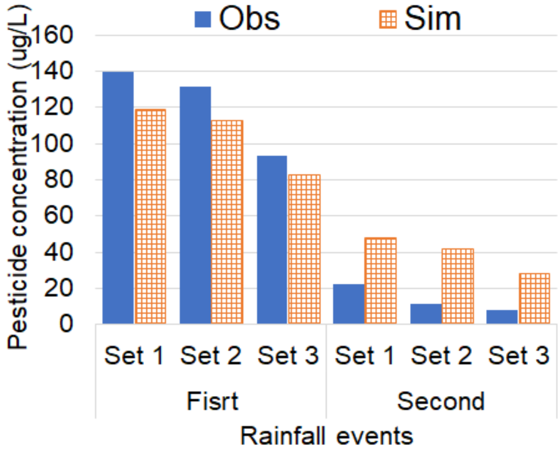

Fig 1. Comparison pesticide concentrations in wash-off water after rainfall.

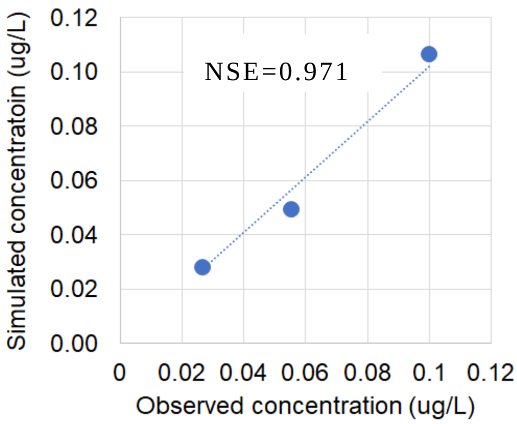

Fig 2. Comparison pesticide concentrations in paddy water after spraying.

4. Conclusions

The PCPF-F model was applied for predicting pesticide fate and transport under foliage application. The model simulated the observed data with acceptable accuracy. However, the model needs to be verified with other pesticides in the long period as well as in the field scale. Furthermore, to improve the model assumption, algorithms and accuracy, detailed information regarding water management, pesticide properties and monitoring concentration in whole paddy system including paddy foliage, water and soil are required. Besides the calibration of the model input parameters are needed in order to achieve better prediction results.

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