Simulation of pesticide dissipation in agricultural soil by SPEC model

SPEC モデルによる農薬消長シミュレーション

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Introduction:

The introduction of pesticide to cropping was a great achievement in increase of agricultural productivity. However, residue of pesticide in agricultural soil after cropping has become a serious concern to farmer and local authorities worldwide because of its effect on food security of and environment pollution. The number of applied pesticides has been changed year by year. Their residue in soil is also varied depended on not only pesticide physical and chemical properties but also hydrological conditions, soil properties as well as weather thus it is difficult to be determined by monitoring. In addition, field monitoring is usually laborious and time consuming and it is hard to provide a comprehensive evaluation of each pesticide products based on only several field monitoring. It is necessary to have a simple tool such as a mathematical simulation model that is able to quickly asset the residue of pesticide under different realistic scenarios.

Objective:

This study aim to develop and validate a simulation model for predicting water movement and pesticide dissipation in bare soil in upland field, and to apply it to evaluate residues in soil of several pesticides in upland field in Japan.

Method:

A mathematical model (SPEC) considering parameters regarding; (1) pesticide properties such as absorption and degradation, (2) soil characteristics such as organic carbon content and soil texture, (3) hydrological condition such as rainfall, runoff and infiltration and (4) climate condition such as soil temperature, was developed to predict pesticide dissipation in soil. The main outputs of the model are volumetric soil water content and pesticide concentration in soil. The model was validated with soil water contents and concentrations of herbicide atrazine monitored in Tsukui farm of Tokyo University of Agriculture and Technology (FM Tsukui), Kanagawa, Japan. It was also further applied to predict dissipation of some pesticides monitored in several years in experimental farm in Chiba Prefectural Agriculture and Forestry Research Center (CAFRC).

Results and Discussion:

SPEC well represented the response of soil water contents against occurrence of rainfall event in FM Tsukui (**Fig.1**). A high prediction precision of soil water contents was also achieved RMSE = 3.3, EF = 0.6 and R2 = 0.6. Water content was peaked at each rainfall event. Runoff occurred only in the high rainfall intensity events.

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The residue of atrazine in soil was also well simulated by SPEC for both application times in summer and winter with RMSE = 39.17, EF = 0.79 and R^2 = 0.91 (***Fig.2***). A faster dissipation of atrazine in summer as compared to it winter was explained by the larger rainfall amount a higher temperature happened during the early period of atrazine application in summer as compared to those in winter.

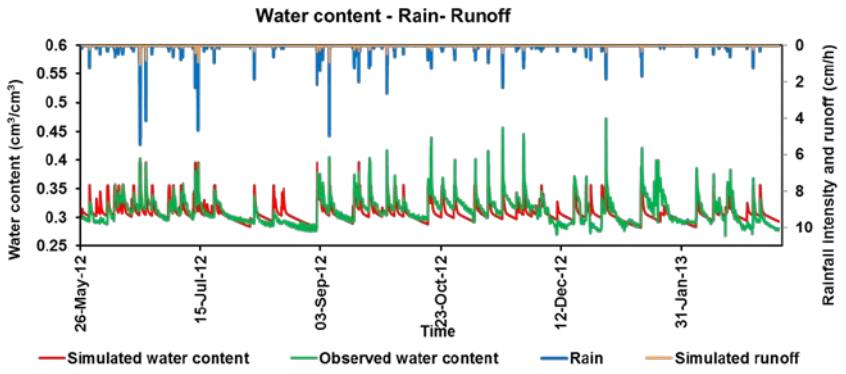

Fig.1 Simulation of soil water content in upland soil

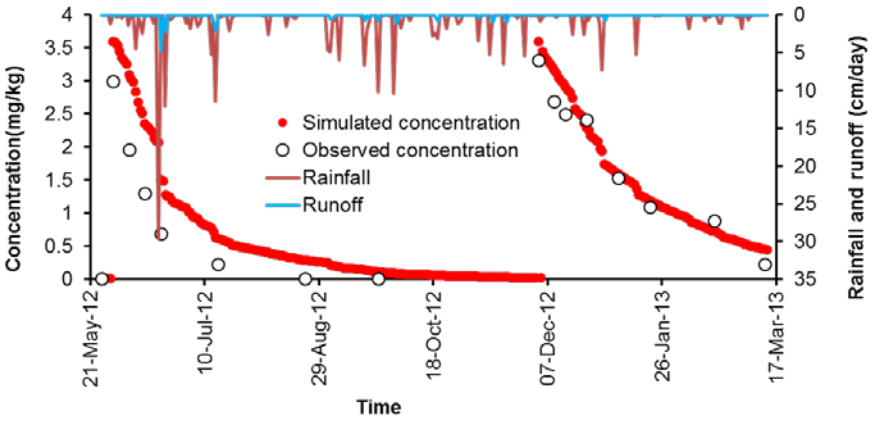

Fig.2 Simulation of atrazine dissipation in upland soil

A good agreement of observation and prediction was also observed in the application of SPEC on some pesticides in experimental farm in CAFRC.

Conclusions

SPEC present as simple tools to asset pesticide residue in agricultural soil. Although it required only few input parameters, it still represented the major processes affecting pesticide dissipation in soil, and it was able to produce acceptable simulation precision. SPEC could be used for quick screening, evaluation and managements of pesticide residue in agricultural soil. For analysis of pesticide runoff response, further calibration of SPEC on pesticide runoff is required.

Note: The data obtained at experimental farm in CAFRC was the product of a project in the Ministry of Environment Japan and the results does not reflect to the policy of the ministry.