Integrated Environmental Impact Risk Assessment System (iEIRAS) for Agricultural Chemical Influence

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Summary of key findings

Integrated Environmental Impact Risk Assessment System (iEIRAS) for influence of three kinds of pesticides (Linuron, Fomesafen, Carbendazim) using Microcosm System was investigated. The iEIRAS is consisted of experimental microcosm system and N88 basic computer simulation model, and main parameter of this system is DO which indicates the ecosystem functional state. The microcosm system was made from three species of phytoplankton as producer, four species of zooplankton as predator, and four species of bacteria as decomposer. To detect the m-NOEC (microcosm NOEC) of each pesticide, the individual number of microorganism as the structural parameter and DO as the functional parameter in the microcosm system were measured. As results, the m-NOEC of Linuron as herbicide was detected as 0.1 mg/L in the functional parameter, but no effect was observed in the time course of biota succession. The m-NOEC of Fomesafen as herbicide was detected as 0.5 mg/L in the structural parameter and as 30 mg/L in the functional parameter. The m-NOEC of Carbendazim as fungicide was detected as in the range of 0.1 mg/L to 1 mg/L in the structural parameter and as more than 10 mg/L in the functional parameter. The strength of Linuron loading influence was indicated as more in production function than in consumption function. Although it is difficult to analysis the function of production and consumption in the microcosm ecosystem by the individual number counting of each microorganism and the measuring of DO in microcosm system, the above information can be obtained using iEIRAS.

Background and relevance

Chemical substances including agricultural chemicals are mentioned as a factor which has serious influence on an ecosystem and biodiversity. To estimate the influence of various chemical substances such as these agricultural chemicals on the ecosystem level, microcosm which is a model ecosystem serves as an effective tool, and the examination example has already been reported. This study was conducted to investigate the influence prediction to the ecosystem of three kinds of pesticides (Linuron, Fomesafen, Carbendazim) using Integrated Environmental Impact Risk Assessment System (iEIRAS) which is consisted of the mathematical model (Sugiura model) and hydrosphere model ecosystem microcosm (Kurihara model).

Integrated Environmental Impact Risk Assessment System (iEIRAS) is a hybrid system of culture model (microcosm) and math model (simulation) (Fig.1). More accurate environmental risk assessment on ecosystem level (multi species test) can be performed. The iEIRAS for influence of herbicide (Linuron) on microcosm system was investigated in this study. The iEIRAS is consisted of experimental microcosm system (Kurihara type) and N88 basic computer simulation model (Sugiura model), and main parameter of this system is DO which indicates the ecosystem functional state.

The microcosm system was made from producer, predator and decomposer. The producer is micro alga such as Chlorella sp., Scenedasmus quadrucauda (chlorophyceae) and Tolypothrix sp. (cyanophyceae). The predator (consumer) is micro animal such as Cyclidium glaucoma (ciliata), Lecane sp., Philodina erythrophthalma (rotifer) and Aeolosoma hemprichi (oligochaeta). The decomposer is bacteria such as Bacillus cereus, Pseudomonas putida, Acinetobacter sp. and coryneform bacteria.

As assessment method, there are individual number counting as structural parameter and DO measuring as functional parameter.
For herbicide loading, Linuron (pesticide), Fomesafen (pesticide) and Carbendazim (fungicide) were added independently at 16th days after the cultivation started (stable state), and loaded volume were, 0 (control), 0.1, 0.2, 0.5, 1.0, 5.0, 10.0, and 30.0mg/l. Cultivation medium was 200ml of TP50 medium (Taub + polypepton 50mg/l) of 300ml vol. Erlenmeyer flask. Culture condition was set up at 25℃, 2,800lux (light 12hr., dark 12hr.) and without stirring. Measurement of individual numbers of each microorganism was conducted at 0, 2, 4, 7, 14, 16, 18, 20, 23, 30days after the cultivation started.

Results

As shown in Fig.2, P/R ratio was almost same in every experimental condition as around 1. In the control microcosm (no loading of Linuron), P and R were 5-7mg/L and P/R ratio was very stabilized as value 1. In 1mg/L Linuron loaded microcosm, P, R and P/R ratio was almost same as control microcosm. In 10mg/L Linuron loaded microcosm, P/R ratio was 1, but P and R were decreased. This means the ecosystem activity was getting lower. From these outcomes, m-NOEC of Linuron was assessed to exist in the rang from 1mg/L to 10mg/L. Loading concentration range between 1 and 10mg/L should be investigated to decide m-NOEC of Linuron. As a time course, the activity of microcosm ecosystem was increased in 1 mg/L loading with increase of DO amplitude. On the other hand, it was decreased in 10 mg/L loading with decrease of that. The strength of Linuron loading influence was indicated as more in production function than in consumption function. Although it is difficult to analysis the function of production and consumption in the microcosm ecosystem by the individual number counting of each microorganism and the measuring of DO in microcosm system, the above information can be obtained using iEIRAS.

By iEIRAS analysis, when coefficient of producer µwas 2-3 and coefficient of consumer µ was 1-1.2, the simullated DO time course and the measured DO time course of Linuron 1mg/L loaded microcosem were similar. From this, the influence on ecosystem function of 1mg/L Linuron loading was assessed as produce function > consume function (Fig.3a).

When coefficient of producer µwas 0.7-4 and coefficient of consumer µ was 1, the simullated DO time course and the measured DO time course of Linuron 10mg/L loaded microcosem were similar. From this, the influence on ecosystem function of 10mg/L Linuron loading was assessed as produce function >> consume function (Fig.3b).
Conclusions

As results, the m-NOEC of Linuron as herbicide was determined as in the range of 1 mg/L to 10 mg/L. As a time course, the activity of microcosm ecosystem was increased in 1 mg/L loading and decreased in 10 mg/L loading. The strength of Linuron loading influence was indicated as more in production function than in consumption function. Although it is difficult to analysis the function of production and consumption in the microcosm ecosystem by the individual number counting of each microorganism and the measuring of DO in microcosm system, the above information can be obtained using iEIRAS.

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