Development of a Portable Rainfall-Runoff Simulator-Plot scale (PRRS-P) for investigating pollutant transport – in case of atrazine and metolachlor transport

汚染物質の挙動解析のための圃場スケール移動式人工降雨装置の開発-アトラジンとメトラクロールの挙動について

Piyanuch Jaikaew[1]*, Farag Malhat[1,2], Julien Boulange[3], and Hirozumi Watanabe[1]

ピヤヌッチ ジャイケーウ [1*],マルハト ファラグ [1,2],ジュリアン ブランジェ [3],渡邊裕純 [1]

1. Background and objectives

Rainfall simulators are essential tools for investigating the process dynamics of surface runoff, infiltration and erosion characteristics. They are also used in researches involving sediment, nutrient, and pollutants transport as well as evaluating the impacts of tillage managements on compaction and infiltration in agricultural soils (Aksoy, Unal et al. 2012). The experiments can moreover be conducted under laboratory condition or in the field, using disturbed or undisturbed soils. The objective of this study was to describe the design and functioning of a new portable rainfall-runoff simulator and to develop the methodology for appropriate investigation of the mobility of pollutant at a field scale.

2. Materials and Methods

Portable Rainfall-runoff simulator development: a Portable Rainfall-Runoff Simulator-Plot scale (PRRS-P) was designed to carry out the rainfall-runoff experiments in the field. The main components of a rainfall simulator are a drop generator, a frame, and a water feeding system (Abudi, Carmi et al. 2012). The simulator developed using a swing emitter which is coupled with two types of silicon nozzles, designed for use over a 1 m by 5 m rainfall catchment area. In order to evaluate the performance of this PRRS-P, a field scale study for atrazine and metalochlor runoff was conducted on 1m x 5m plot of slight slope (5%). Herbicides were applied as recommended rates and rainfall events were simulated with 50

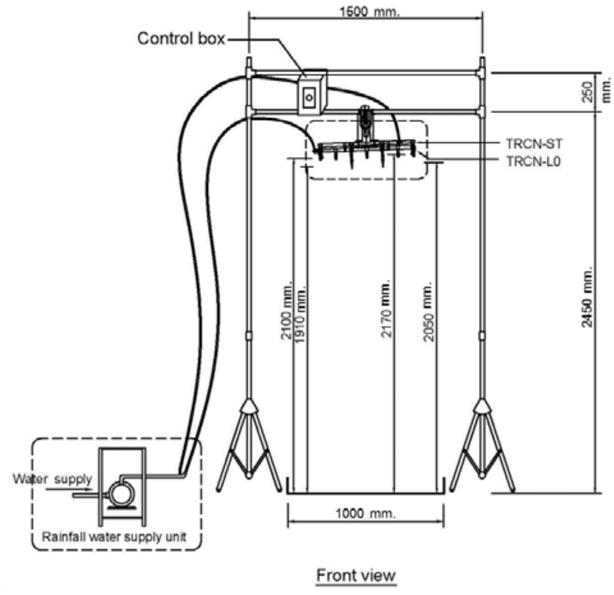

Fig 1. Portable Rainfall-Runoff Simulator-Plot scale (PRRS-P)

所属：[1]東京農工大学，[2]エジプト中央農薬研究所 [3]明治大学；Affiliation：[1]Tokyo University of Agriculture and Technology,[2]Central Agricultural Pesticide Laboratory, Egypt,[3] Meiji University
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mm/h (SD:±4mm/hr) intensity 1day and 7days after application without replications. The runoff was sampled at 10 min intervals for 60 minutes from the runoff start during the simulated events. Herbicides concentrations were determined in the water and sediment of the collected surface runoff.

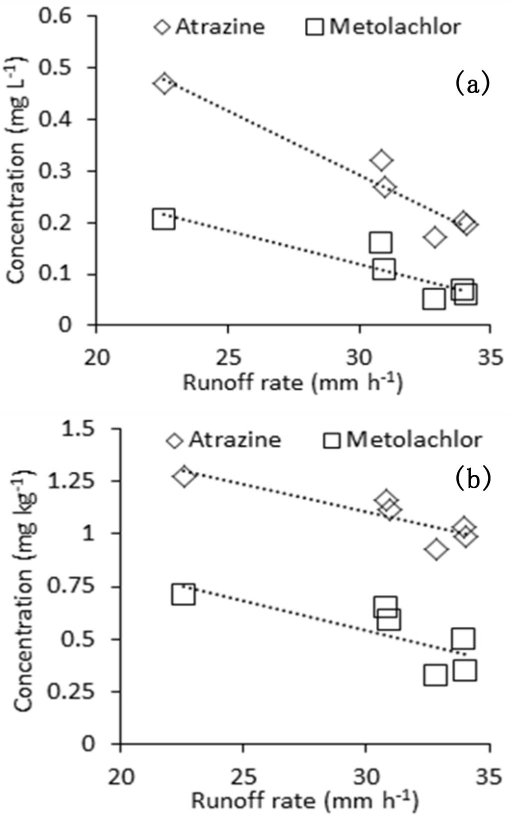

Fig2. Atrazine and metolachlor concentrations as function of the runoff rate in runoff water (a) and in sediment (b)

3. Results and discussion

The developed simulator provided rainfall intensities between 20 and 100 mm h^{-1}. The variable rainfall intensities were obtained by varying the number and type of nozzles used. The Christiansen coefficients of uniformities were appropriate and varied from 79 to 94 % for rainfall intensities ranging from 30 to 70 mm h^{-1}. The median volumetric drop diameters measured for rainfall intensities of 50mm h^{-1} were higher than that of natural rainfall and equal to 1.69±0.21mm. The peak concentrations were 0.46 and 0.35 mgl^{-1} for atrazine and metolachlor, respectively (Fig. 2a). Atrazine and metolachlor were also transported in the solid phase, adsorbed to eroded soil particles (Fig. 2b). The sediment always contained more atrazine than metolachlor, which can be attributed to the lower water solubility of atrazine as compared to metolachlor. The distributions of atrazine and metolachlor concentrations were similar and the highest concentrations of herbicides were detected in the top 5 cm of the soil surface. Indeed, no herbicides were detected in the 5-10 and 10-15 cm soil layers. Relative to the herbicide applied mass, 48.06% and 41.95% of atrazine and metolachlor mass were detected in the soil, respectively.

4. Conclusions

The rainfall simulator developed in this study can produce various rainfall intensities on a 5 m^2 rainfall catchment area in remote locations for runoff studies. The greatest advantages of this simulator are its portability and its capability of operating at continuous flow, requiring no complex mechanisms to control the rainfall intensity. The constructed simulator was easy-to-use tool, low-cost, and easy to transport and assemble in field, thus allowing the necessary experimental replicates to be carried out. The PRRS-P system demonstrated the runoff characteristics of atrazine and metolachlor under preset rainfall simulation in upland field condition.

Reference：Watanabe et al.,（2007）Weed Biology and Management, 7, 44–54