Nitrogen Cycle in Sandy Fields under Different Irrigation Scheduling Strategies
異なる灌漑水量の決定法による砂丘畑の窒素循環

○Ieyasu Tokumoto, Haruyuki Fujimaki*, Masashi Shibata*, and Kosuke Noborio**
○徳本家康，藤巻晴行*，柴田雅史*，登尾浩助**

1. Introduction

Arid and semi-arid regions require sustainable irrigation system to maximize crop yield income. We developed an automatic scheduling irrigation system and a scheduling method with internet weather forecast service (simulated irrigation method) for crop yield. In particular, evaluation of effective strategies for reducing nitrogen loss from agricultural fields is significant. The objective of this study was to evaluate nitrous oxide (greenhouse gas) emissions and nitrate leaching from corn fields with the chamber method when the two different irrigation methods were applied to the best management practice for corn product.

2. Materials and methods

The experiment sites were 16 m by 20 m plots for each drip irrigation systems at the Arid land research center (35°32’N, 134°13’E), Japan (Fig. 1a). The soil was a siliceous sand with a shallow groundwater level down to 9 m below soil surface. We measured nitrous oxide, carbon dioxide, and methane fluxes using a closed chamber and analyzed the data using gas chromatography. Nitrate (NO_3^--N) leaching was sampled at the bottom of lysimeter (Fig. 1b), and analyzed by ion chromatography. Soil water content (θ), evaporation were monitored with TDR measurements and weighing lysimeter.

A drip irrigation method was used for the two different irrigation scheduling methods. The interval for simulated irrigation was two days, and automatic irrigation was applied when θ at the depth of 15 cm was less than 0.09 $m^3\ m^{-3}$. After sweet corn was sown on June 4th, automatic and simulated irrigation methods were carried out. At each plot, irrigation water was applied with liquid fertilizers (urea and calcium chloride).

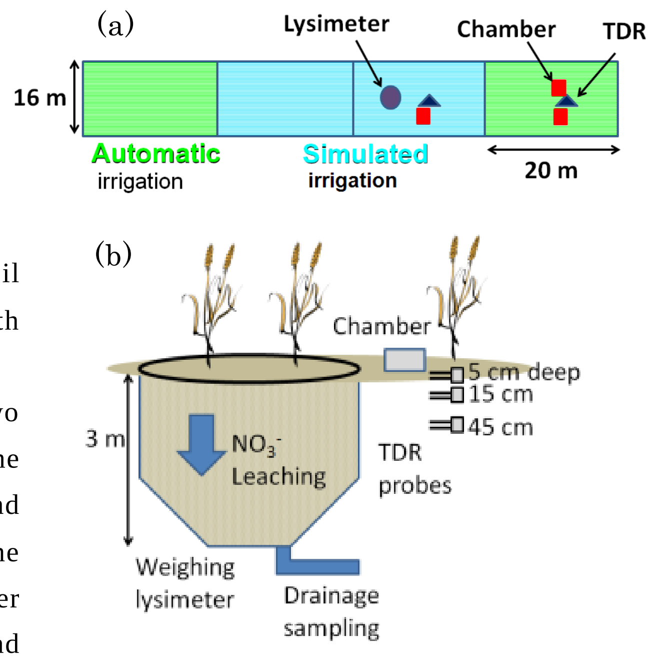

Fig. 1 Schematic figures of different irrigation systems in field plots (a) and weighing lysimeter system (b).

For simulated irrigation scheduling strategies, Wash-2D model, process model developed by Fujimaki and Sasaki (2010), was used to calculate water, solute, and heat transport with a

Faculty of Agriculture, Saga University, Arid Land Research Center, Tottori University*, Faculty of Agriculture, Meiji University** 佐賀大学農学部，鳥取大学　乾燥地研究センター*，明治大学農学部**
Keywords: Sandy fields, Scheduling irrigation system, Greenhouse gases, Nitrate leaching,

finite difference method.

3. Results and discussion

Figure 2 shows comparisons of θ and greenhouse gas (GHG) emissions between automatic and simulated irrigation methods. Simulated irrigation method maintained θ at a depth of 5 cm, providing most of the water consumed by corn (Fig. 2c). GHG flux was very low because soil organic matter is low in the sandy field (Figs. 2b and 2d), but high NO_3^--N level (> 10 mg L^{-1}) was observed during the corn growing period (Fig. 3). To maximize the corn yield, nutrient supplies were needed with a large amount of irrigation water. However, hydraulic conductivity of sand increases, as θ increases. Thus, excess NO_3^--N leaching would be caused by timing issues of irrigation scheduling. The simulated irrigation strategies will require NO_3^--N reduction to manage the nitrogen cycle at sandy fields.

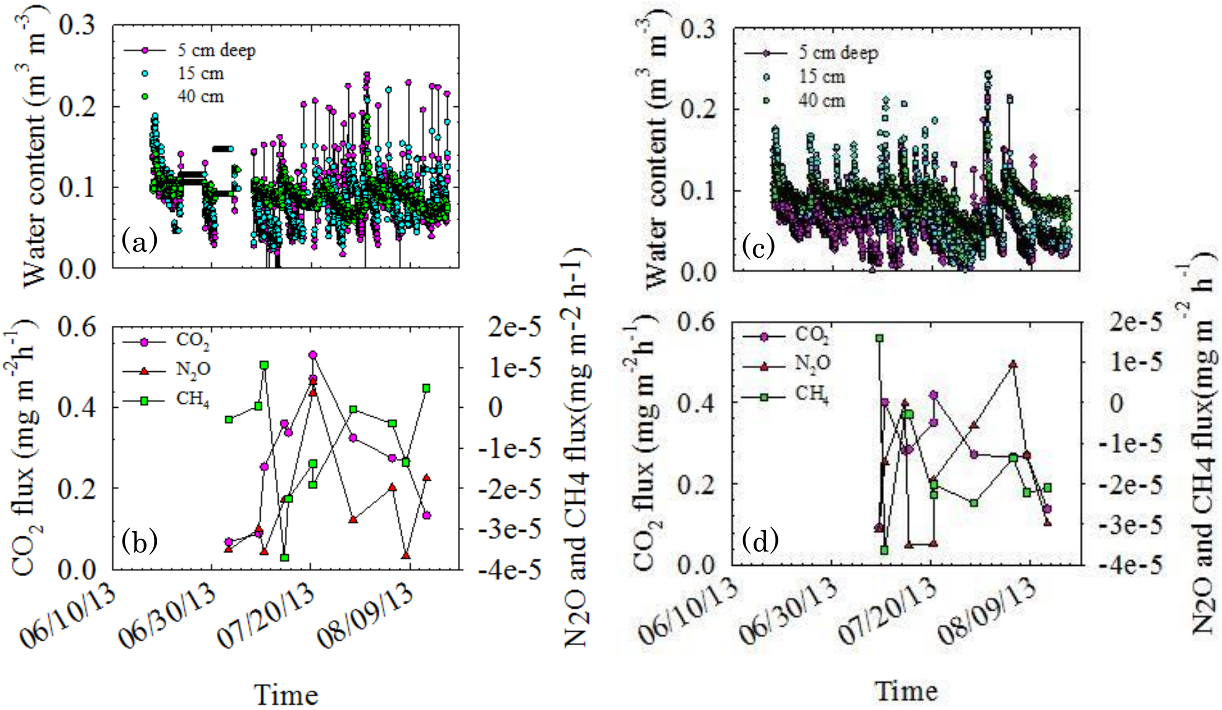

Fig. 2 Temporal changes in θ (a) and GHG fluxes (b) at automatic irrigation plots to compare with θ (c) and GHG fluxes (d) at simulated irrigation plots.

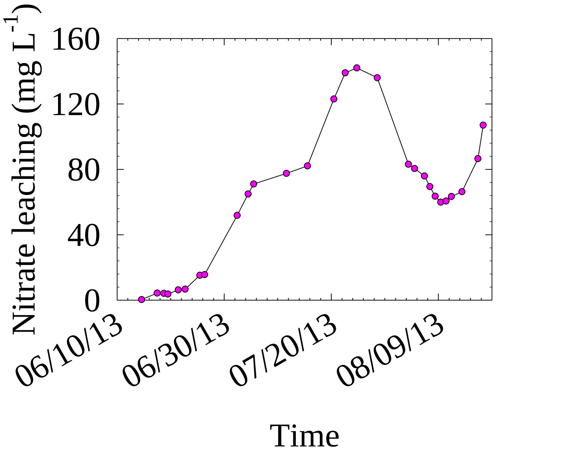

Fig. 3 Changes in NO_3^--N concentration at a depth of 3 m in weighing lysimeter.

[Ref.] Fujimaki H. and Y. Sasaki, Determination of irrigation depths using a numerical model and quantitative. 19th World Congress of Soil Science, Soil Solutions for a Changing World.
URL:weatherforecasthttp://www.iuss.org/19th%20WCSS/Symposium/pdf/1315.pdf

[Acknowledgements] This research project was supported by JSPS (Res. Number: 25892019) and a research grant from Japanese Society of Sand Dune Research.