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Modeling the effects of excess water on soybean growth in converted paddy field in Japan 1. Predicting groundwater level and soil moisture condition - The case of Biwa lake reclamation area

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Abstract

In Japan, more than 80 % of soybean growing area is converted fields and excess water is one of the major problems in soybean production. For example, recent study (Yoshifuji et al., 2016) suggested that in the fields of shallow groundwater level (GWL) (< 1m depth), rising GWL even in a short period (e.g. 1 day) causes inhibition of soybean growth. Thus it becomes more and more important to predict GWL and soil moisture in detail. In addition to conventional surface drainage and underdrain, FOEAS (Farm Oriented Enhancing Aquatic System), which is expected to control GWL in fields adequately, has been developed recently. In this study we attempted to predict GWL and soil moisture condition at the converted field with FOEAS in Biwa lake reclamation area, Shiga prefecture, near the center of the main island of Japan. Two dimensional HYDRUS model (Simuinek et al., 1999) based on common Richards' equation, was used for the calculation of soil water movement. The calculation domain was considered to be 10 and 5 meter in horizontal and vertical direction, respectively, with two layers, i.e. 20cm-thick of plowed layer and underlying subsoil layer. The center of main underdrain (10 cm in diameter) was assumed to be 5 meter from the both ends of the domain and 10-60cm depth from the surface in accordance with the field experiment. The hydraulic parameters of the soil was estimated with the digital soil map in "Soil information web viewer" and Agricultural soil-profile physical properties database, Japan (SolphyJ) (Kato and Nishimura, 2016). Hourly rainfall depth and daily potential evapo-transpiration rate data were given as the upper boundary condition (B.C.). For the bottom B.C., constant upward flux, which meant the inflow flux to the field from outside, was given. Seepage face condition was employed for the surrounding of the underdrain. Initial condition was employed as GWL=60cm. Then we compared the simulated and observed results of volumetric water content at depth of 15cm and GWL. While the model described the variation of GWL well, it tended to overestimate the soil moisture through the growing period. Judging from the field condition, and observed data of soil moisture and GWL, consideration of soil structure (e.g. cracks and clods) in determination of soil hydraulic parameters at the plowed layer may improve the simulation results of soil moisture.

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Keywords: excess water, paddy-upland rotation, soil moisture, groundwater level, HYDRUS-2D.

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