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Modeling the effects of excess water on soybean growth in converted paddy field in Japan. 2. modeling the effect of excess water on the leaf area development and biomass production of soybean

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Abstract

The low and unstable yield of soybean has been a major problem in Japan. Excess soil moisture conditions are one of the major factors to restrict soybean productivity. More than 80 % of soybean crops are cultivated in converted paddy fields which often have poor drainage. In central and eastern regions of Japan, the early vegetative growth of soybean tends to be restricted by the flooding damage because the early growth period is overlapped with the rainy season. Field observation shows that induced excess water stress in early vegetative stage reduces dry matter production by decreasing intercepted radiation by leaf and radiation use efficiency (RUE) (Bajgain et al., 2015). Therefore, it is necessary to evaluate the responses of soybean growth for excess water conditions to assess these effects on soybean productions. In this study, we aim to modify the soybean crop model (Sinclair et al., 2003) by adding the components of the restriction of leaf area development and RUE for adaptable to excess water conditions. This model was consist of five components, phenological model, leaf area development model, dry matter production model, plant nitrogen model and soil water balance model. The model structures and parameters were estimated from the data obtained from the field experiment in Tsukuba. The excess water effects on the leaf area development were modeled with consideration of decrease of blanch emergence and individual leaf expansion as a function of temperature and ground water level from pot experiments. The nitrogen fixation and nitrogen absorption from soil were assumed to be inhibited by excess water stress and the RUE was assumed to be decreasing according to the decline of leaf nitrogen concentration. The results of the modified model were better agreement with the field observations of the induced excess water stress in paddy field. By coupling the crop model and the ground water level model, it may be possible to assess the impact of excess water conditions for soybean production quantitatively. This study was in part supported by Cross-ministerial Strategic Innovation Promotion Program (SIP) (funding agency: Bio-oriented Technology Research Advancement Institution, NARO).

Keywords: soybean, crop model, leaf area development, excess water

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