Tropentag, September 10-12, 2025, hybrid conference

"Reconcile land system changes
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Multi-location evaluation of oryza2000 model in simulating anthesis and maturity dates of rice varieties in Bangladesh

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Abstract

Accurate simulation of phenological stage is crucial in the application of crop growth models to predict eco-physiological and yield processes. ORYZA2000 is the most widespread crop model for simulating rice growth in different rice cropping systems where the phenological output is driven mainly by temperature and by eight crop parameters. However, significant spatial variability in climatic conditions, along with the cultivation of diverse rice varieties, introduce substantial uncertainty in model applications. Determination of crop phenological parameters are important for the simulation of other crop growth processes and for modelling upscale. We integrated the ORYZA2000v2v13 model to the SIMPLACE modelling framework then investigated model sensitivity and performance in predicting phenological stages in Bangladesh which is one of the top rice producers worldwide. The field measured data includes dates of anthesis and maturity of 20 rice varieties grown over 3 seasons (2020–2022) and 4 locations (Cumilla, Mymensingh, Rangpur, and Sunamganj). Sensitivity analysis using the Morris and Extended FAST methods revealed that the parameter cDVRP (development rate during panicle development, °Cd ^{1}) significantly influenced anthesis prediction, with total effect (*) and interaction effect ( ) values of 55 and 59 days, respectively. Similarly, cDVRJ (development rate during the juvenile phase, °Cd ^{1}) had even higher sensitivity, with * = 67 and = 85 days. In contrast, cDVRR (development rate during the reproductive phase, °Cd ^{1}) was found to be most critical for simulating maturity, with * = 43 and = 86 days. Variety-specific model calibration based on different combinations of those three parameters in 2020 in Cumilla shows a good simulation of anthesis and maturity dates with average root mean square error (RMSE) of 5 and 3 days, respectively. However, model validation across the remaining seasons and locations showed variable prediction accuracy, with RMSE ranging from 8–25 days for anthesis and 9–32 days for maturity. This suggests that the variety-specific parameters derived from one season and location is not generic enough for other seasons and locations. Further work should focus on the calibration processes to find suitable parameters that capture the interaction of genotype with location and seasonal changes in temperature.

Keywords: Morris scanning, sensitivity analysis, sIMPLACE, temperature, uncertainty

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