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Advances in Modeling Crop Physiological Processes

Soo-Hyung Kim*

School of Environmental and Forest Sciences, University of Washington, Seattle, WA, USA

Crop growth is coordinated by multiple physiological processes. Process-based crop models (PBCMs) simulate growth, development, and performance of a crop plant by modeling its underlying physiological processes (e.g., photosynthesis, transpiration, respiration, organ development, and assimilate transport) and their coordinated integration into the whole-plant behavior. Most PBCMs are explanatory models by nature as they integrate sub-models that represent the mechanisms and processes at lower levels of biological organization into the whole-crop level responses. Thus, PBCMs are powerful tools to investigate the integrative effects of multiple plant processes and their interactions with environmental, management, and genetic factors. Much progress has been made in our understanding of individual physiological processes. Here, I provide an overview of the advances made historically and today in modeling key crop physiological processes with a focus on the processes associated with carbon acquisition and allocation (photosynthesis, stomatal conductance, respiration, and assimilate partitioning), and the timing of plant developmental events (phenology) using flowering control mechanisms as an example. Areas for further improvements are addressed.

* Correspondence to : soohkim@uw.edu