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구조기능 모델 구축을 위한 파프리카 프로세스 모델 원형 개발

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Developing a Process-based Prototype Model for Building Functional-structural Plant Model of Paprika

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Functional-structural plant model (FSPM) is a crop growth model that integrates 3d-structure of plants into a process-based model. Modelling of plant architecture enables more reliable simulations of canopy light interception and horticultural practices (e.g., defoliation, pinching, fruit thinning) compared to the classical processed-based model. Most of the classical models don't simulate the detailed plant structure development such as growth and expansion of individual leaf, elongation of individual internode, etc. In this study, we aimed to build a process-based model of paprika that can simulate crop growth by organ unit (individual leaf, stem, and fruit), which will be further integrated with a 3d-structure model for building FSPM.

Phenology module was developed using L-system and a temperature-response function of organ growth and development. Light interception of canopy was calculated according to Lambert-Beer's law, and photosynthesis was calculated for each leaf considering the position of leaves. The maintenance- and growth-respirations of leaf, stem, and fruit were calculated in individual organ unit. Modules for defoliation, pinching, and fruit thinning (or harvesting) were included in the model. The model was coded in python.

The developed model was validated with the experimental data (node number, leaf dry weight, and stem dry weight of a cultivar "Scirocco") from the National Institute of Horticultural and Herbal Science. The model underestimated node number (RMSE = 2.54 g plant^{-1}, R^2 = 0.82) and leaf weight (RMSE = 28.23 g plant-1, R2 = 0.41), but overestimated stem weight (RMSE = 6.78 g plant^{-1}, R^2 = 0.92). Although the model was not calibrated with the experimental data except for the phenology module, the model performance was acceptable. This prototype model will be further calibrated and validated with additional experiments before integrating with the 3d-structure model.

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