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L-Rose: a model simulating organ expansion of individual plants within a bush rose crop

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Highlights: A model has been developed to simulate the dynamics of expansion of the individual organs of bush rose primary shoots. This model is designed to provide a tool calibrated on experimental data to investigate plant response to phylloclimate, especially light.

Keywords: architectural modeling, expansion, FSPM, L-systems, *Rosa hybrida* L., bushrose

Three-D empirical models that mimic accurately the dynamics of plant architecture can be used, together with physical models, to investigate the climate perceived at the level of individual organs. In bush rose the commercial product is the individual plant and its architecture determines its visual quality. It is thus important to explain not only mean plant architecture but also interplant architectural variability, which can be high in bush rose canopies. The aim of this work was to develop a model that reproduces the expansion of primary shoots within bush rose canopies accounting for interplant variability. Our model is designed to be calibrated on a minimal amount of non-destructive and easy-to-measure experimental data.

An analysis of organ expansion dynamics using datasets obtained in three different growing conditions (different years and densities) was undertaken to find out stable relationships at the individual plant scale that coordinate the expansion along time of the individual organs. A first set of relationships relates the rates of expansion of individual leaves or internodes to their relative position along the shoot and their final length. A second set of relationships coordinates the timing of organ expansion. We showed that leaf and internode of a same phytomer expand almost simultaneously and that expansion periods of successive leaves and internodes overlap. The time of maximal expansion rate for leaves and internodes is related to the time of leaf appearance. A third set of relationships deals with leaf allometry, relating length and width of all leaflets to a unique dimension that is terminal leaflet length. These relationships were used to build a model that was implemented in L-Py (Boudon et al. 2012) under the OpenAlea platform (Pradal et al. 2008). The model was tested using cross-validation, it correctly reproduced the dynamics of expansion of leaflets and internodes of individual primary shoots (RMSEP of 7.3% and 10.2% of final length, respectively, when the analysis was conducted at individual plant scale), using solely measurements of organ numbers and sizes at the end of primary shoot growth and of phyllochron. This first version focused on the phase preceding branching since it will first be used to investigate budbreak regulation.

The originality of the model is to account for inter-plant variability in expansion within a crop. In a next step this model will be coupled with a light model to explore the relationships between local light environment and bud break in bush rose, aiming to explain both mean crop behavior and interplant variability.

LITERATURE CITED

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