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Modelling the Guayule plant growth and development with a Functional Structural Plant Model

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Introduction

The Guayule (*Parthenium argentatum, Asteraceae*), is a small ramified tree native to the northern Mexico and southwestern United States. The guayule shows a growing interest in research and agriculture (Ray, 1993). However, the production itineraries in relation to latex production are still not assessed, and so far little studies were done on the plant structure and functioning. This study aims to propose a first FSPM of the species using the GreenLab model, calibrated from data issued from two varieties in different environmental conditions.

Materials and Methods

The studying methodology is first based on a qualitative architectural analysis (Barthelemy and al., 2007). Second, on the various axis typologies, the development and branching stochastic rules can then be retrieved from field internode distributions collections. Finally, the organ source and sink relations parameters can be fitted from dedicated dry weight measurements (Kang et al., 2018).
Experimental plots were hold south of France, close to Montpellier on two varieties CL1 and CLA1, with four environmental conditions related to density and hydric pressure (no stress, low stress and high stress).. The sampling was optimized to the plant structure and to quantify the polyisoprene and resins contents.

Results and Discussion

The guayule shows a sympodial development is composed of modules with terminal inflorescence. Its architecture corresponds to the Leeuwenberg's model (Hallé et al., 1978). The axes are constituted of successive modules. Studying the plant structure, we found out that the number of relay axis per module follows a binomial distribution. The modules are ordered from the plant base to the top. And these modules are composed of internodes whose number also follows a binomial law, which parameters are quite stable from one order to another. In the further modelling process, we thus did consider that the plant elementary unit was the module, called as a meta-phytomer. Under this assumption, we summarized the total dry weight of leaves and internodes per module to build the axis organic series (Buis and Barthou, 1984). Field measurements issued from these two series constituted then a target to be adjusted by the structural functional GreenLab model (Kang et al, 2018) in order to calibrate the organ source parameters. An initial analysis calculated the strength sink of leaves and internodes in a context of free growth and analysed the differences between the two varieties. We are currently applying the methodology to assess the impact on the parameters of development and growth, the effects of planting density and irrigation.

Conclusions

This first modelling study hold on two varieties on the Guayule tree shows that the plant structure can be efficiently modelled using a simple module approach. The development parameters, defining the module number of phytomers and branching rules are nearly stable and close for both varieties under the various environmental conditions. First functioning parameters were also retrieved from the measurements. These parameters make it possible to obtain the first stochastic 3D simulations of the Guayule's growth and architecture for both varieties.

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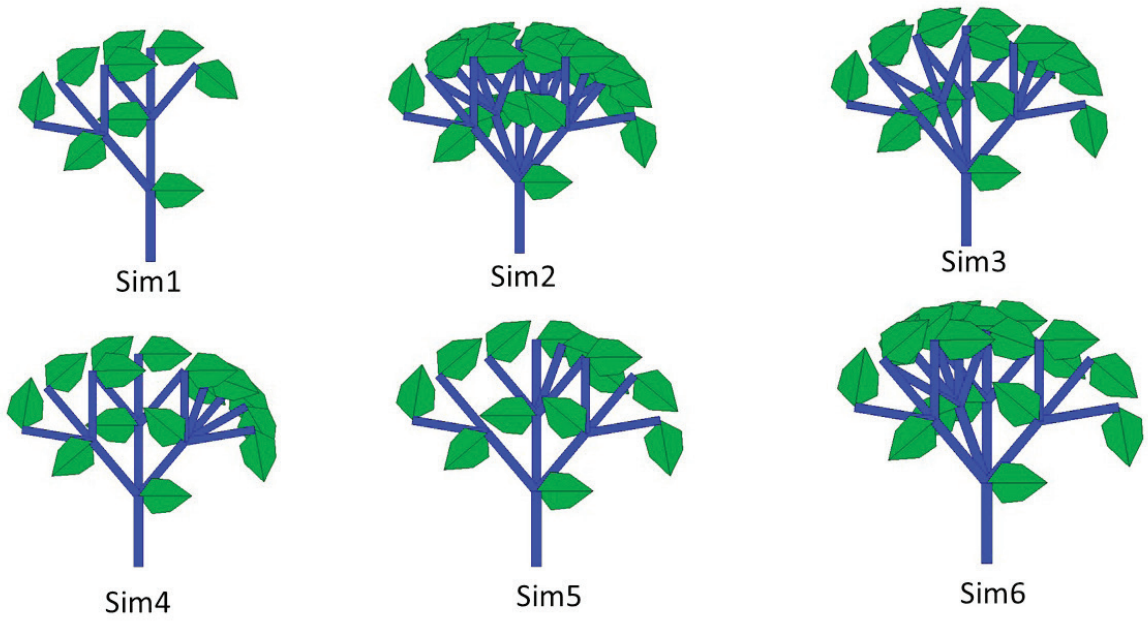

Six stochastic Guayule model simulation at age 5, using metaphytomers (each module with its leaves is replaced by a unique metaphytomer and a single leaf).

Keywords: Guayule, FSPM, GREENLAB, module, rubber.

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