



HAL
open science

CHARACTERIZATION OF THE THIGMOMORPHOGENETIC RESPONSE OF RUBBER TREE CLONE (HEVEA BRASILIENSIS) : IMPACT ON WIND BREAKAGE STRENGTH

Engonga Edzang, Eric Badel, Rostand Moutou Pitti, Joseph Gril, Moulia
Bruno

► **To cite this version:**

Engonga Edzang, Eric Badel, Rostand Moutou Pitti, Joseph Gril, Moulia Bruno. CHARACTERIZATION OF THE THIGMOMORPHOGENETIC RESPONSE OF RUBBER TREE CLONE (HEVEA BRASILIENSIS) : IMPACT ON WIND BREAKAGE STRENGTH. World Conference On Timber Engineering, Aug 2021, Santiago, Chile. hal-03042580

HAL Id: hal-03042580

<https://hal.science/hal-03042580>

Submitted on 6 Dec 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

CHARACTERIZATION OF THE THIGMOMORPHOGENETIC RESPONSE OF RUBBER TREE CLONE (HEVEA BRASILIENSIS) : IMPACT ON WIND BREAKAGE STRENGTH

ENGONGA EDZANG A.C¹, BADEL Eric², MOUTOU PITTI R.^{3,6}, GRIL Joseph⁴, MOULIA Bruno⁵

ABSTRACT: There is a difference in resistance to wind breakage quite marked between the different of rubber tree clones (*Hevea brasiliensis*). The objective of this work is to understand this difference in sensitivity. More precisely, we would like to characterize the thigmomorphogenetic capacity for wind hardening of rubber tree clones. Also, in-situ trunk flexion tests will be performed with imposed strain. A follow-up growth in diameter will be carried out to evaluate the thigmomorphogenetic responses induced by these solicitations. The behavior of the different trunk profiles will also be analyzed using the finite element model of trunk flexion on Cast3m software.

KEYWORDS: Biomechanics; Wind-breaking; *Hevea brasiliensis*; Thigmomorphogenesis

1 INTRODUCTION

Wind is a natural disturbance for forest ecosystems. The process of wind damage is very similar in all plants. Two types of wind damage can be distinguished: i) Chablis, which refers to overturning and uprooting mainly involving the root structure; ii) the volis that interests us, refers to the breaking of the trunk and a partial or total loss of the crown of the tree [1] [2]. These damages can be significant and generate significant production losses in plantations, such as rubber tree plantations for latex production.

In addition to mechanical stresses due to the wind, the rubber tree in plantation also undergoes physiological stresses related to bloodletting and stimulation by ethylene. Several studies have been conducted to try to understand the wind sensitivity of rubber tree clones. Studies conducted in particular on the architectural structure of rubber clones [3] [4]. For example, the work of Cilas et al [4] on two rubber clones (GT1 and PB235) shows that GT1 develops short lateral branches, while PB235 develops elongate axillary branches. These results give information on an important parameter in wind damage, namely: the size of the area exposed to the wind. This may partly explain the breakage sensitivity of

the PB235 over the GT1, with the former having greater size of the area exposed.

Thus, like these studies, we are interested here on the one hand, the different trunk profiles of rubber clones encountered in plantations. To the impact of these trunk profiles on the wind resistance of trees. In particular, on the bottled form resulting from the local secondary growth after stimulation with ethylene. On the other hand, we are interested in the thigmomorphogenetic capacity of these different clones and its impact on the wind resistance of these clones.

2 MATERIAL AND METHODS

The experimental device will be set up in a rubber tree plantation (Fig. 1a) where two clones will be selected; including one estimated very brittle and the second estimated resistant.

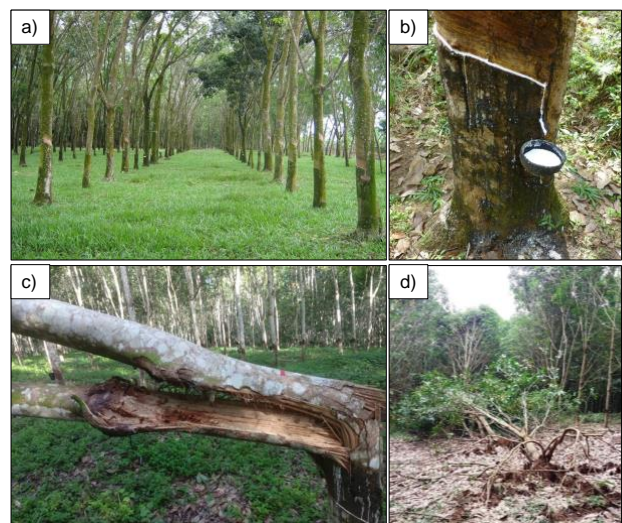


Figure 1: (a) rubber tree plantation; (b) bleeding panel; (c) trunk failure due to wind; (d) tree uprooting due to wind

¹ Arnauld. C Engonga Edzang, Université Clermont Auvergne, INRA, PIAF, France, arnauld.engonga-edzang@inra.fr

² Badel Eric, Université Clermont Auvergne, INRA, PIAF, France, eric.badel@inra.fr

³ Rostand Moutou Pitti, Université Clermont Auvergne, France, rostand.moutou_pitti@uca.fr

⁴ Gril Joseph, Université Clermont Auvergne, INRA, PIAF, France, joseph.gril@cnrs.fr

⁵ Moulia Bruno, Université Clermont Auvergne, France, INRA, PIAF, bruno.moulia@inra.fr

⁶ Rostand Moutou Pitti, IRT, Gabon, rostand.moutou_pitti@uca.fr

Figure 1 presents a plantation of rubber trees and the various damage that one observes there. We can see a bloodletting panel with latex flow (Fig 1b) and two wind damage including a trunk break (Fig 1c) and uprooting (Fig 1d).

It will be a question of performing bending tests (Fig. 2a) on these different clones. The experimental device will consist of a hand winch (Fig. 2e), a traction cable, a load cell (Fig. 2b) to measure the applied force, a strain sensor (Fig 2c) and an inclinometer (Fig 2d) to measure a possible inclination of the base of tree due to uprooting.

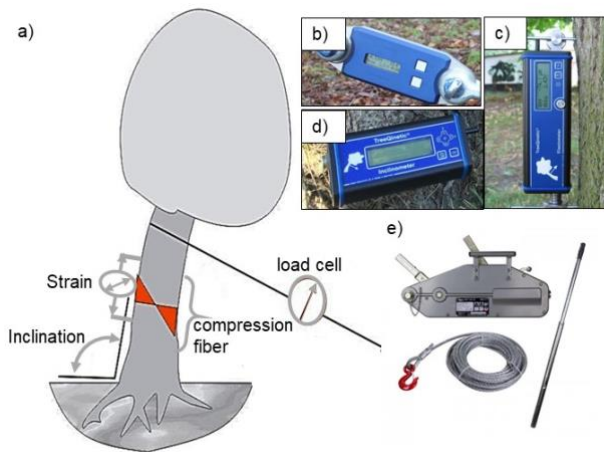


Figure 2: Schema of a bending test and measuring instrument

The flowchart in Figure 3 presents the outline of the finite element calculation of the trunk flexion model. First of all we define the geometric parameters of the tree such as the diameter at the base of the trunk and the height at the point of loading. Then we define the geometry of the trunk (profile) and the mechanical properties of the wood. The root system will be considered a perfect embedding. We will calculate the displacement, stress and deformation fields related to mechanical blockage (root system). Finally, we will determine the deflection for each level of loading.

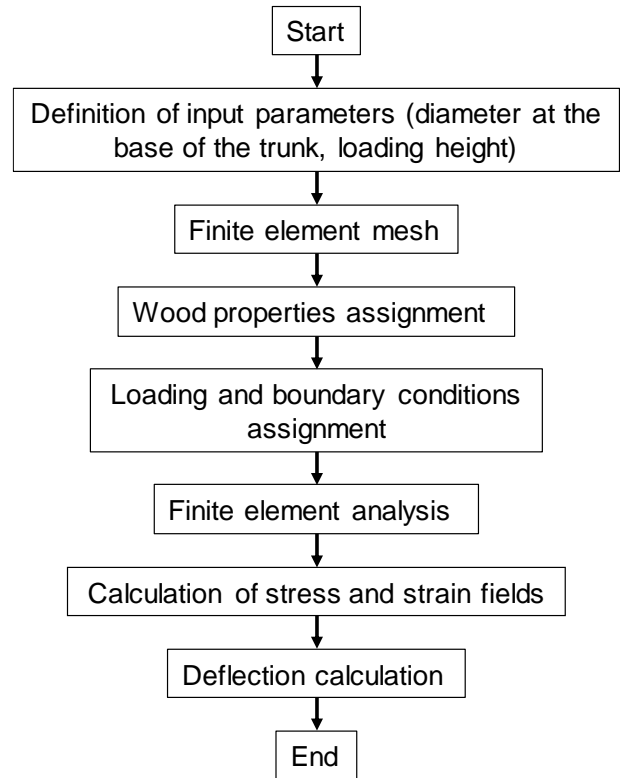


Figure 3: Flowchart of the calculation by finite element calculation on cast3m

3 EXPECTED RESULT

Interesting results are obtained according to the observation posted in Figure 1 and the experimental setup described in Figure 2. Then, the elastic characteristics of the green wood of the different clones from the determination of the rigidity of the tree are obtained. A comparison between the finite element bending model and the experimental results obtained through the tests to validate the model is performed.

ACKNOWLEDGEMENT

The authors thank the Ecole Doctorale des Sciences Pour l'Ingénieur de l'Université Clermont Auvergne (EDSPI) for the financial support to attend this conference.

REFERENCES

- [1] Gardiner B, Berry P, Moulia B. Review: Wind impacts on plant growth, mechanics and damage. *Plant Science*, 245, 94-118, 2016.
- [2] De Langre E. Effects of wind on plants. *Annu Rev Fluid Mech*, 40, 141-168, 2008.
- [3] Hofmann J P. Etude morphogénétique de la couronne de clones d'Hevea brasiliensis résistant et sensible à la casse au vent. *Annales des sciences forestières*, 41, 87-102, 1984.
- [4] Cilas C, Costes E, Milet J, Legnaté H, Gnagne M, Clément-Demange A. Characterization of branching in two Hevea brasiliensis clones. *Journal of Experimental Botany*, 399, 1045-1051, 2004.