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Mechanistic-statistical modelling of Coffee Berry Disease dynamics and elucidation of the epidemiological mechanisms affected by shade

Natacha Motisi [1], Julien Papaïx [2], Sylvain Poggi * [3]

1 Centre de coopération internationale en recherche agronomique pour le développement [CIRAD] : UR 106 (Cirad) –Campus International de Baillarguet 34398 Montpellier cedex 5, France
2 INRA-BioSP – Institut National de la Recherche Agronomique - INRA – INRA, Biostatistiques et Processus Spatiaux - BioSP, Domaine St Paul, Site Agroparc, 84914 Avignon, France
3 Institut de Génétique, Environnement et Protection des Plantes (IGEPP) – Institut national de la recherche agronomique (INRA) : UMR1349, Agrocampus Ouest : UMR1349 – AGROCAMPUS OUEST, UMR1349 IGEPP, F-35042 Rennes, France

Coffee berry disease (CBD), which is widespread in Africa, has been responsible for massive yield losses of *Coffea arabica*. In Cameroon, *C. arabica* is mainly cropped in agroforestry systems on smallholder farms where low incomes hinder the use of chemicals to manage the disease. Investigations on novel agroecological strategies to control CBD are expected to be implemented and even increase in the current context of global changes. Shade trees are supposed to reduce the dispersion of CBD by forming a barrier against rain. Nevertheless, data collected over two consecutive years in West Cameroon showed that shading did not necessarily reduce the disease and could even increase it. The objective of our study was to determine the epidemiological mechanisms and environmental covariates involved in the differences of epidemics observed under shade and full sun. For this purpose, we have developed a Susceptible – Exposed - Infectious - Removed model (SEIR), some parameters of which being functions of environmental covariates. This dynamic model has been coupled to a probabilistic model of observation via a mechanistic-statistical approach. The estimation of model parameters was performed in a Bayesian framework with the JAGS software. Our results showed that (i) CBD was governed by subtle balances between microclimate variables and (ii) shade had antagonistic effects on several epidemiological parameters. These findings suggest that depending on the local conditions, a particular effect could take the advantage resulting in a high variability between experiments described in the literature. Hence contrasting effects of shade trees on disease dynamics need more in depth evaluation to precise the possible trade-offs between the epidemiological and environmental variables at stake. We recommend the mechanistic-statistical modelling approach to help design novel, cost-effective and environmentally friendly management strategies both at the plot and landscape scales.

*Speaker