Using sensitivity analyses to identify and optimize key parameters of sharka management strategy

Gael Thébaud, Loup Rimbaud, Claude Bruchou, Sophie Thoyer, Sylvie Dallot, C. Picard, Samuel S. Soubeyrand, Emmanuel Jacquot

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Thébaud, G. (1), Rimbaud, L. (1), Bruchou, C. (2), Thoyer, S. (3), Dallot, S. (1), Picard, C (1), Soubeyrand, S. (2), and Jacquot, E. (1)

(1) INRA, UMR 385 BGPI, Cirad TA A-54/K, Campus de Baillarguet, 34398 Montpellier Cedex 5, France (thebaud@supagro.inra.fr)
(2) INRA, UR 546 Biostatistics and Spatial Processes, Avignon, France
(3) Montpellier SupAgro, UMR LAMETA, Montpellier, France

BACKGROUND and OBJECTIVES

Strategies for disease control are often based on expert opinions rather than on the formal demonstration that they are, at least in theory, effective. This mainly stems from the complexity of taking into account the biological processes and the human interventions that both impact disease spread. A promising approach to optimize disease management consists in modeling both the epidemic processes and control measures. In this way, the most influential parameters can be identified, and alternative control strategies can be proposed and tested *in silico* in order to assess their potential efficiency.

MATERIALS and METHODS

We developed a spatially-realistic stochastic SEIR (susceptible – exposed – infectious – removed) model simulating disease dynamics (introduction, latent period and dispersal function) and management (surveillance, removal and replanting conditions). Then, we defined epidemiological and economic criteria that were used in global sensitivity analyses and to optimize the model parameters.

RESULTS

First, we carried out generic sensitivity analyses with parameter ranges large enough to encompass values that are typical of many perennial plant diseases and of their management. These analyses revealed the importance of the latent period duration, and highlighted the key contributors to disease management impact. Then, we specifically scrutinized the main processes affecting sharka epidemics, caused by *Plum pox virus*, a quarantine pathogen of prunus trees (especially apricot, peach and plum) in many areas of the world (Rimbaud et al., 2015). Using realistic parameter ranges given the present knowledge of sharka epidemiology, the introduction of infectious plants and the removal procedure appeared to be the main levers for management optimization. A last sensitivity analysis on the most promising control parameters enabled the theoretical economic optimization of sharka management strategy.

CONCLUSIONS

We are now expanding this framework to study the potential impact of disease management based on landscape optimization. The identified optimal control strategies are discussed with the organizations responsible for sharka control in order to help the design of durable and cost-effective strategies.

REFERENCES

Rimbaud, L., Dallot, S., Gottwald, T.R., Decroocq, V., Soubeyrand, S., Jacquot, E., Thébaud, G. (2015) Sharka epidemiology and worldwide management strategies: learning lessons to optimize the control of plant virus diseases. *Annual Review of Phytopathology* 53: 357-378.