Global risk predictions for Pierces disease of grapevines

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The clonal lineage of the bacterium *Xylella fastidiosa* (Xf) responsible for Pierce's disease (PD)[1] poses a threat to viticulture worldwide [2]. Although this vector-transmitted disease has remained mainly restricted to the United States, recent introductions on the islands of Majorca (Spain) and Taiwan have raised concerns about the risk of spreading worldwide [3]. To assess this risk, here we build a climate-driven epidemiological model that simulates PD progression (Fig. 1). The model considers the temperature-dependent infection process based on a 3-year inoculation assay and assume local disease propagation when climatic conditions are favourable. The model was successfully validated with spatiotemporal data of the PD distribution in the United States yielding a remarkable ∼90% accuracy. Thereafter the model was applied to the main winegrowing regions worldwide, specially focusing in Europe as a case study based on the distribution of the main vector, *Philaenus spumarius*.

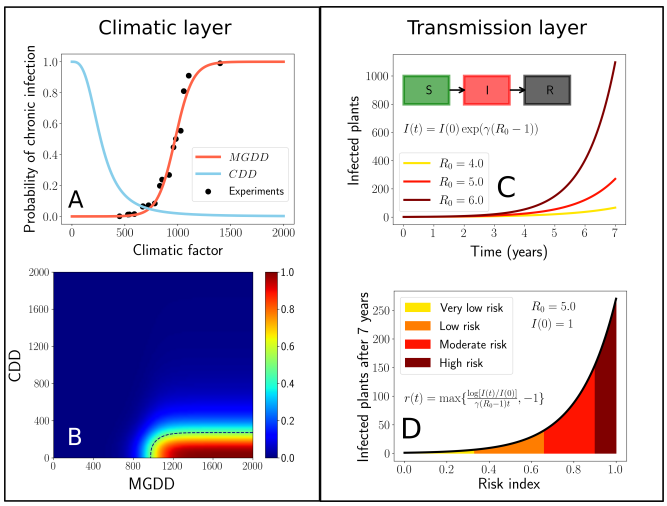

Fig. 1. Climatic and transmission layers composing the epidemiological model. A) Relationship between the likelihood of infection and temperature-related metrics(*CDD* and *MGDD*). Black dots depict the 3-y inoculation assay. (**B**) Combined ranges of $MGDD$ and CDD on the likelihood of developing chronic infection. (**C**) Transmission layer of the dynamic equation. (**D**) Relationship between risk index and the number of infected plants.

Our model simulation reveals that most wine-quality producing areas in China, Europe, Argentina, Chile, South Africa, and Australia currently thrive in non-risk or transient-risk zones (Fig. 2). To a lesser extent, epidemic-risk zones with low to moderate risk indices appear in coastal zones such as Mallorca and Apulia, where Xf outbreaks have been already detected. The European case shows how models assuming a vector heterogeneous distribution yield lesser extended epidemic-risk zones than previous risk maps. Overall, a global expansion of PD epidemic-risk zones is projected for 2050, although with low increase in risk indices. Our study highlights the importance of considering climate variability and an invasive criterion to obtain precise risk maps for plant health decision-making.

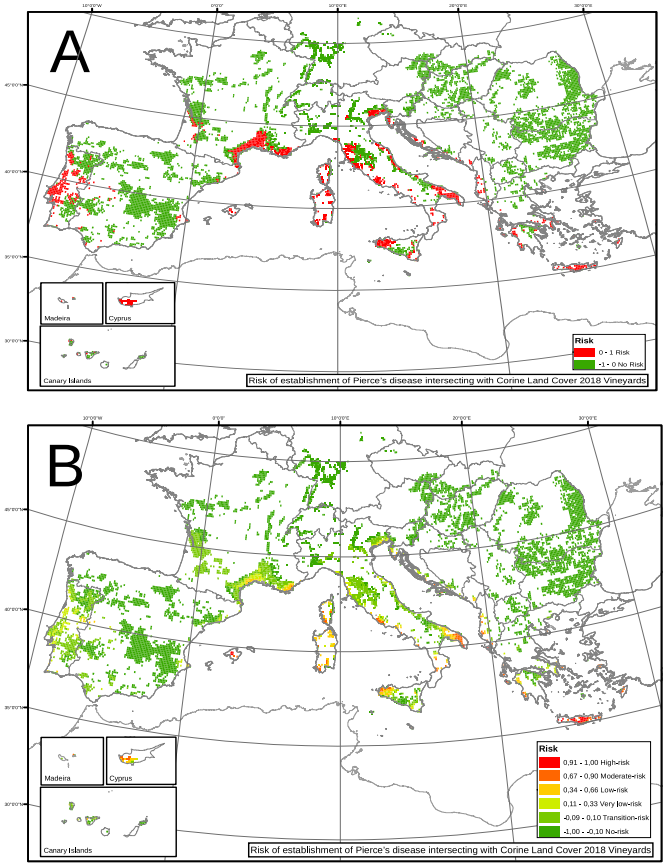

Fig. 2. Climate-driven risk map for PD establishment under a baseline $R_0 = 5$ scenario in Europe. (A) Binray risk map. (B) Risk map divided in severity indices.

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[3] Moralejo, E. et al., Plant Pathology **109**, 222-224 (2019).