An epidemiological model integrating landscape heterogeneity and airborne connectivity: The case of brown rot of peach in France

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Résumé

Plant disease dynamics are driven by the concurrent interplay of host susceptibility, environmental conditions and pathogen presence. We propose an original metapopulation framework integrating landscape heterogeneity, in terms of climate and host density, where populations of plant hosts are connected via air-masses which allow pathogen dispersal. We explicitly account for climatic drivers affecting pathogen transport while modelling aerial dispersal using Lagrangian simulations, as well as host phenology and infection. We calibrate the model parameters according to the literature and using Approximate Bayesian Computation against observations of brown rot incidence in French peach orchards from 2001 to 2020 across an area of 50,000 $km2$. We use the model to produce maps of risk, distinguishing site dangerousness (risk of causing secondary infection in other sites) and vulnerability (risk of becoming infected). We demonstrate that airborne transport of *Monilinia* spores is essential in describing the spread of brown rot in French orchards. We find that most dangerous and vulnerable sites are located along the Rhône Valley, due to the concurrence of high density of peach cultivation, a suitable climate and persistent airborne connections. Our work represents a first step to integrate metapopulation theory, epidemiology and air-mass movements to inform plant protection strategies at the national level. Furthermore, it could be adapted to optimize crop protection under future climate projections.

Mots-Clés: metapopulation, network, epidemics, crop protection, agronomy, brown rot, peach

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