Mathematical Biology Seminar

Monday, November 19, 2018
3 pm – 457 CAB

Frederic Hamelin

Agrocampus Ouest Rennes, France

Taking advantage of pathogen diversity and plant immunity to minimize disease prevalence

The effects of pesticides on public health and the decline of biodiversity are alarming. Alternative methods to control plant diseases are urgently needed. Taking up this scientific challenge requires strong theoretical bases. Host mixtures are a promising component of future agro-ecological solutions but their design remains to be optimized. In plant disease epidemiology, whether and how host mixtures may reduce disease prevalence has long been studied, both theoretically and empirically. In particular, it is well known that pathogen diversity and plant immunity are key to the possible success of host mixtures against plant diseases. This is because pathogen genotypes that produce little or no symptoms on some plant genotypes trigger a long-lasting immune response protecting against subsequent infections from other pathogen genotypes; this is a form of cross immunity. However, this phenomenon was thus far absent from mathematical models aiming at designing host mixtures. In this study, we explored under which circumstances two pathogen genotypes can coexist in a mixture composed of two host genotypes, and how this affects the total prevalence of the disease. In addition, we assessed the ecological and epidemiological implications of cross immunity triggered by one pathogen genotype on one host genotype. We showed that there is an optimal fraction of each host genotype to be achieved to minimize disease prevalence. The existence of such an optimal fraction is a direct consequence of cross immunity. The stronger the host immune response, the stronger the reduction in disease prevalence brought by host mixtures. Our results highlight the importance of considering both pathogen diversity and plant immunity in designing optimal host mixtures. Future research in behavioral epidemiology may help achieving optimal mixtures in the field.
This is a joint work with Pauline Clin, Frédéric Grognard and Florence Val.