A multi–seasonal model of crop mixtures for plant disease control

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Yves Fotso Fotso[1,2], Frédéric Hamelin[1]

[1] Institut Agro, Univ Rennes, INRAE, IGEPP, Rennes, France

[2]Univ. Rennes, Inria, CNRS, IRISA, Rennes, France
{yves.fotso-fotso@inrae.fr, frederic.hamelin@institut-agro.fr}

Protecting crops by natural means is a prerequisite for the transition to healthy, environmentally–friendly agriculture. Its aim is to enable growers to avoid using pesticides and to preserve biodiversity while limiting the appearance or transmission of diseases. Mixing crop species in a field can be an effective and sustainable way of managing epidemics. It can help reduce the damage and spread of pests and diseases in agricultural fields. While this practice is proving useful against plant pathogens, how it works is still poorly understood.

To tackle this issue, we formulate a multi–seasonal epidemiological model describing the transmission dynamics of a pathogen in a mixed population of two crops, one of which is a host and the other a non–host of the pathogen. We study the long–term dynamics of this model. Our results show that mixing two crops (one host and one non–host) provides effective control of the pathogen, reducing the prevalence of the disease. However, this efficiency is linked to the fraction of non–hosts. We show that there is a critical fraction of non-host plants that maximizes the density of healthy hosts at equilibrium at the end of growing season. Furthermore, taking into account the economic value of the host crop at the end of growing season, there is an optimal fraction of non–host that maximizes economic utility.