A Mathematical Model of Coffee Rust

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Coffee rust is a disease of coffee plants. The cause of coffee rust disease is the fungus Hemileia vastatrix. Since 2010 there has been a particularly severe epidemic of coffee rust in Central America. The disease has very serious economic consequences for countries where it is endemic. The spread of the disease involves complex interactions between four organisms: the coffee rust fungus, the white halo fungus, the green coffee scale insect pest and the ant, Azteca instabilis. The only previous mathematical model of coffee rust (Vandermeer, Jackson and Perfecto, 2014) consists of two differential equations. The Vandermeer, Jackson and Perfecto model is incomplete because it involves only two of the four organisms, the mutualistic interaction of the ant and the green coffee scale is ignored, and it does not attempt to model the hyperparasitism of the white halo fungus. A theoretical analysis of the four differential equations of the model proposed in this project shows that they have solutions for which the interactions of the four organisms result in stable populations of each and in which the population of coffee rust is a small fraction of its carrying capacity. When these stable populations are perturbed the populations return to their original stable values. The model suggests that, with a detailed understanding of the interactions of the four organisms, and, in particular, the effect of the hyperparasitism of the white halo fungus, the spread of coffee rust can be controlled without the use of pesticides and sprays.

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