Effect of resource levels (fertilization) on epidemics and crop pathogen evolution

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Abstract

Crop pathogens display a high adaptive potential to agricultural practices. We use a model of life history evolution of wheat fungal pathogens aiming to understand how they could adapt to changes in fertilization practices. To tackle this issue, we need to keep track of the developmental schedule of the plant and the one of the pathogen. We used a physiologically structured population model, being a theoretical framework capable of integrating these two developmental scales. A wheat plant is modeled as a collection of patches whose age reflects both their spatial position within field canopy and their nutrients level. Introducing a second structure in terms of age of infection of patches allows us to know precisely the amount of nutrients transformed into mycelium or spores, and to implement pathogen dispersal. We focus on a single pathogen life history trait (latent period) which directly determines the amount of resource allocated to growth and reproduction (fitness as lifetime reproduction).

For different fertilization scenarios, we were able to identify a value of the latent period maximizing spore production. We found a positive relationship between the optimal latent period and fertilization, resulting from two trade-offs : one in local resource allocation and another in canopy colonization. The importance of the dynamical aspects of canopy colonization is highlighted by a race between canopy growth and pathogen spore dispersal. Because the latent period correlates to the pathogen's generation time, a sudden decrease of nitrogen enrichment (advocated by agroecologists) could have profound effects on the shape of fungi epidemics.

Keywords: Fertilization, Wheat rust, Epidemiology, Physiologically Structured Population Model

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