Does the long incubation period of Zymoseptoria tritici result from ecological constraints?

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Abstract

Zymoseptoria tritici causes a damaging foliar disease on wheat. This hemibiotrophic fungus has an unusually long, symptomless incubation period, during which the pathogen remains in the apoplast at low densities, hidden from the plant's immune system. Why does *Z. tritici* have such a long incubation period? Based on ecological theory, we propose that an advantage of a longer incubation is a delay of leaf damage, favouring host growth. To test this hypothesis, we developed a consumer-resource-based epidemiological model. When fungal symptoms appear at the end of the incubation, we assume that locally photosynthesis is reduced and therefore resources available for plant growth as well. The incubation period also determines the onset of pathogen sporulation. For the pathogen, the cost of permitting plant growth is hence late sporulation. We show that there is an optimal incubation that maximizes spores production over the season. We further show that the optimal incubation depends on the pathogen's "virulence", in its ecological definition as the level of host damage caused by the pathogen. Our model predicts that more virulent strains have a longer optimal incubation in order to maintain enough plant growth for developing epidemics. However, due to the pathogen's limited dispersal distance, the optimal incubation also depends on plant architecture as taller plants favor a shorter incubation to avoid newly emerging leaves escaping disease from the lower infected leaves. The optimal incubation thus results from a tradeoff between delaying host damage and colonizing the growing plant. We argue that the long incubation of *Z. tritici* may be a so-called "milker" strategy to delay host damage and thereby increase fungal fitness. This work is a first step to increase our understanding of the evolution of such hemibiotrophic fungi, which we argue is essential in the agroecological context of developing sustainable strategies for crop disease control.

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