Plant resistance to pathogens: just you wait?

Timothée Poisot based on peer reviews by Jean-Paul Soularue and 1 anonymous reviewer

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In this preprint, Rimbaud et al. (2023) examine whether Adult Plant Resistance (APR), where plants delay their response to pathogens, is a viable alternative when the solution to evolve complete resistance from the seedling stage exists. At first glance, delaying resistance seems like a counter-intuitive strategy, unless it can result in a weaker selection of the pathogen, and therefore slow down its adaption to plant resistance.

The approach of Rimbaud et al. is to incorporate as much of the mechanisms as possible into a model. By accounting for explicit spatio-temporal dynamics, stochasticity, and the coupling between demography and population genetics, to simulate an agricultural landscape, they reach a nuanced conclusion.

Weaker and delayed activation of genes that confer APR does indeed reduce the selection pressure acting on the pathogen, at the cost of overall less effective protection. The alternative strategy of rapid or complete activation of these genes, although it results in better results in defending against the pathogen, is at risk of being overcome because it introduces a stronger selection pressure.

One important feature of this work is that it accounts for agricultural practices. The landscape that is simulated can account for monoculture, mosaic cultures, mixed cultures, and rotations of crops (with different strategies for resistance). This introduces an interesting element to the conclusion: that human practices will have an impact on the selection pressures acting within the system.

Perhaps the most striking result is that, for the plants, it might be more beneficial to bear the cost of a wild-type pathogen that can benefit from delayed activation of resistance, and therefore exclude the more virulent strains by simply being there first, and essentially buying the plant some time before it activates its resistance more completely. When the landscape is aggregated, even wild-type pathogens can cause severe epidemics; increasing fragmentation, because it enables connectivity between patches of plants with different strategies, allows pathogens to move across cultivars, and reduces the epidemic risk on susceptible plants.

These results should encourage scaling up the perspective on APR, and indeed Rimbaud et al. adopt a landscape-scale perspective, to show that APR genes and genes conferring more complete resistance early on can have synergistic effects. This is, again, both an interesting result for evolutionary biologists, but also a useful way to prioritize different crop management strategies over large spatial scales.

References:

Rimbaud, Loup, et al. Durable Resistance or Efficient Disease Control? Adult Plant Resistance (APR) at the Heart of the Dilemma. 2023. bioRxiv, ver. 2 peer-reviewed and recommended by Peer Community in Evolutionary Biology. https://doi.org/10.1101/2022.08.30.505787

Reviews

Evaluation round #1

DOI or URL of the preprint: https://doi.org/10.1101/2022.08.30.505787
Version of the preprint: 1

Authors' reply, 17 April 2023

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Decision by Timothée Poisot, posted 19 March 2023, validated 20 March 2023

Minor improvements on model presentation are required before recommendation

Dear authors,

I would like to apologize for the delay in returning a decision. We had to invite many reviewers in order to secure two reviews.

I have now received two reviews, and they are positive about the manuscript, but request modifications (that are very minor), mostly to clarify how the model works (which, I think, can be addressed in an appendix), or how the model's simulations are transformed in measurements (which, I believe, should be in the main text).

Please provide a point by point response to the comments; I do not anticipate having to send the preprint out for review again, so please do make sure the response is detailed enough that I can write my recommendation when it is resubmitted.

Montréal, March 19, 2023
Timothée Poisot

Reviewed by Jean-Paul Soularue, 05 March 2023

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Reviewed by anonymous reviewer 1, 12 February 2023

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