Improving sustainable crop protection using population genetics concepts

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Abstract

Growing genetically resistant plants allows pathogen populations to be controlled and reduces the use of chemicals. However, pathogens can quickly overcome such resistance. In this context, how can we achieve sustainable crop protection? This crucial question has remained largely unanswered despite decades of intense debate and research effort. In this study, we used a bibliographic analysis to show that the research field of resistance durability has evolved into three subfields: (i) 'plant breeding' (generating new genetic material), (ii) 'molecular interactions' (exploring the molecular dialogue governing plant–pathogen interactions) and (iii) 'epidemiology and evolution' (explaining and forecasting of pathogen population dynamics resulting from selection pressure(s) exerted by resistant plants). We argue that this triple split of the field impedes integrated research progress and ultimately compromises the sustainable management of genetic resistance. After identifying a gap among the three subfields, we argue that the theoretical framework of population genetics could bridge this gap. Indeed, population genetics formally explains the evolution of all heritable traits, and allows genetic changes to be tracked along with variation in population dynamics. This provides an integrated view of pathogen adaptation, notably via evolutionary–epidemiological feedbacks. In this Opinion Note, we detail examples illustrating how such a framework can better inform best practice for developing and managing genetically resistant cultivars.

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