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Environmental nitrogen and phosphorus supplies alters prevalence and competitive interactions among two plant viruses

Christelle Lacroix*, Eric W. Seabloom, Elizabeth T. Borer

Department of Ecology, Evolution, and Behavior, University of Minnesota, Saint Paul, MN 55108, USA
* Current address: *INRA, UR0407 Plant Pathology, Montfavet Cedex F-84143, France. E-mail: christelle.lacroix@paca.inra.fr*

Resource-ratio theory has widely been used to explain outcomes of competitive interactions between species in communities of plants and other free-living organisms. Yet, we have little empirical data on the effects of nutrient supplies on the interactions among microbial organisms that use plants as hosts. A framework for understanding the mechanisms governing the assembly of plant microbial communities would be an important advance because plants often host a diversity of micro-organisms, and interactions among co-occurring microbes can alter both host and microbe population dynamics. To better understand the effects of nutrient supplies to hosts on microbe interactions, we singly inoculated and co-inoculated plants of one annual crop species (*Avena sativa*, Poaceae) with two systemic and phloem-restricted virus species, barley yellow dwarf virus-PAV (BYDV-PAV, Luteovirideae) and cereal yellow dwarf virus-RPV (CYDV-RPV, Luteovirideae). Host plants were grown across a factorial combination of N and P supply rates. P addition lowered CYDV-RPV prevalence. N addition altered the interaction strength among viruses. The co-inoculation of BYDV-PAV lowered CYDV-RPV infection rate, but this antagonistic interaction only occurred at low nutrient supply rates and disappeared at high N supply rate. These results provide insights on how nutrient-host-virus interactions might drive microbe community composition and increase the risk of co-infection, especially in light of the global scale of human alterations of biochemical cycles.