REACS

Designing REsilient stone fruit trees via integrative phenotyping in low phytosanitary input orchards and Association genetiCS

ABSTRACT

The Prunus orchard must address an urgent societal and environmental demand for pesticide reduction and has to face unexpected epidemiological changes due to climate change in a context of intense exchanges of plant material across borders. Adapting Prunus crops to these challenges implies a reevaluation of the current breeding methodology to breed resilient trees, i.e. trees able to sustain their production over the years in the presence of multiple pests (e.g. aphids, leafhoppers, moths) and pathogens (e.g. viruses, bacteria, fungi). To date, although a real discussion on this topic has been engaged, adequate experimental designs for observing the manifestation of resilience and to dissect the different phenotypic and genetic components of the “resilient ideotype” are lacking. Resilience phenotyping requires the screening of a vast genetic diversity in the field, under low input conditions, with multiples pest/diseases symptoms being scored over several years.
This project allies the expertise of Prunus geneticists and breeders (INRAE GAFL), epidemiologists of fruit tree pests and diseases (CIRAD & INRAE PHIM) and specialists in association genetics (INRAE AGAP) to support a PhD student in pioneering an innovative breeding methodology by measuring resilience, identifying resilient ideotypes and associated genetic markers in Prunus. It relies on an extant multisite, multispecies orchard design where diversified panels (called core-collections) of two major stone fruits are planted. In those populations of 150 and 206 individuals (respectively for apricot and peach), genomic data and pilot phenotypic data will be available upon the start of the project. After a first phase of bibliography to identify the concept of resilience and the means for measuring its manifestation in the orchard, the doctoral student will organize the phenotyping of all visible symptoms occurring on this plant material under low phytosanitary input. By combining all the data collected on the core-collections before the project (2018-21) and acquired over two vegetative seasons during the project (2022-23), she/he will quantify the cumulated sensibilities to pests and diseases and their evolution over two to five years, while identifying phenological and environmental covariates helping their interpretations. Using the multi-trait data, she/he will create new variables describing tree resilience. Next, the student will perform genome-wide association studies (GWAS) in a multisite and multitrait design to understand the genetic architecture of its components in interaction with the environment. The comparison between the two species will help advancing current research on the main aspects of low-input ideotyping in Prunus, and we expect that this knowledge will also prove valuable for improving other fruit productions. Thanks to a close collaboration of INRAE with breeders, useful markers and progenitors might be rapidly exploited to create new, more resilient varieties.

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GOAL

The broad research question addressed in this work is whether and how it is possible to breed for resilience in stone fruit. To answer this question, methods need to be developed to measure resilience, identify resilient ideotypes and control the inheritance of resilience in stone fruit. The PhD will pioneer these objectives by examining the use of genetic resources in two major Prunus species as a leverage to i) uncover the fundamental principles of resilience in stone fruit, ii) find genetic markers associated to resilience and/or resilience components, such as resistances and tolerances to individual pests and diseases iii)identify potential resilient progenitors useful for pre-breeding activities. Thus, by increasing our understanding of stone fruit resilience at the phenotypic and genetic levels, this project will contribute in the long term to make resilience a concrete breeding target for breeders.