We are looking for a motivated M2 Master student on the topic:

Defining and harnessing resilience traits in stone fruit (*Prunus*)

Painting by Kandinsky

Context

Pesticide reduction in agriculture is both an environmental and societal necessity. Unlike in annual plants, in perennial plants such as *Prunus*, pesticides are used over many years to protect trees from the juvenile phase to the end of the production stage. Targeted organisms include bacteria, fungi, insects causing a long list of diseases (*i.e.* bacterial canker, monilia, leaf curl, sharka to name a few). Considering that current cultivars have been selected under conventional practices (*i.e.* with pesticides), and because most cultivars are sensitive to multiple diseases, simply removing plant protection from the orchard management would result in high yield loss, or even in the dieback of entire orchards. In other words, modern cultivars do not have the potential to be compatible with more environmentally-friendly practices.

What are the most efficient solutions? One important leverage is to breed for disease resistance, meaning to be able to trace the genetic origin of resistance and to incorporate it via natural crosses to produce our favorite varieties.

This is where genetic diversity into play. Disease resistance and tolerance are present in natural habitats of wild *Prunus* species, and to find it, we need to screen a wide panel of genetic resources under conditions of "zero pesticides". By combining genetic information from markers and field observations, we will not only be able to identify the most robust individuals, but also to identify what regions to look for in our breeding programs to harness disease resistance. The main statistical method we will use for this goal is called Genome Wide Association Analysis (well known as GWAS) and you can read more on that here: https://nph.onlinelibrary.wiley.com/doi/epdf/10.1111/j.1469-8137.2010.03593.x

To deal with these questions, the student will have to get familiar with a diversified panel of plant material (peach and apricot), to learn how to score the symptoms of different diseases and to perform statistical analyses under our supervision. Thus, this internship is aimed to be interdisciplinary, and the student will benefit from the local expertise in these fields: plant pathology and genetics will be the core scientific disciplines and field work as well as data analyses/statistics will be the tools. This is clearly a task involving **agriculture x environment interactions** with strong societal implications in the background.

Plant populations elaborated for this work stem from the project CarResPrunus:
https://www6.paca.inrae.fr/gafl/Partenariats-et-projets/Projets-nationaux/CaRessPrunus

One of our papers on the topic:

Omrani, M., Roth, M., Roch, G., Blanc, A., Morris, C. E., & Audergon, J. M. (2019). Genome-wide association multi-locus and multi-variate linear mixed models reveal two linked loci with major effects on partial resistance of apricot to bacterial canker. *BMC plant biology*, 19(1), 31.

Your research questions:

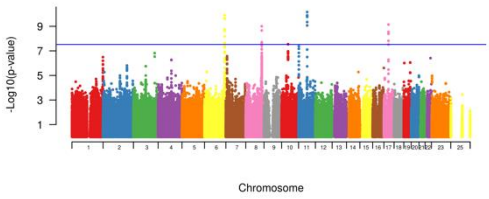
- What are the best traits to phenotype resilience in low input management?
- What is the variability of resilience across environments?
- Can we identify genotypes with outstanding resilience?

Your main tasks:

- Phenotyping disease resistance in the field in peach and/or apricot tree collections, in low input conditions at multiple sites in Southern France
- Quantify the environmental vs. genetic impacts on resilience with statistical analyses
- Perform genome-wide association analyses
- Identify resilient genotypes and resilience markers
- Produce a report with results on field work and their interpretation for breeding

You will learn:

- How to score fruit tree diseases in the field
- How to analyze phenotypic data from multiple trials
- How to disentangle genetic and environmental effects in your observations
- Some population genetics - to understand the genetic diversity of your plant material
- Data visualization and statistical methods that you can translate to other scientific fields
- More generally to get familiar with plant breeding activities and their implications



Output from a genome-wide association analysis (GWAS)
Dots above the line are genetic markers having an potential impact on the trait of study

The DADI team (Diversity, Adaptation, Determinants, Integration) is located near Avignon. The team is specialized in stone fruits and tomato genetics and breeding.
More info here: https://www6.paca.inrae.fr/gafl/Equipes-de-recherche/Diversite-Adaptation-Determinants-et-Integration/Membres-de-l-equipe-DADI

The internship will involve travel to 3 to 4 sites located in Southern France, where the experiments are replicated. Technical aspects on this point can be discussed and adjusted.
Please contact us for more details.

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