JOB POSITION

PhD proposal: Identification of the molecular mechanisms behind viral manipulation of plants to promote transmission by aphid vectors

The French National Research Institute for Agriculture, Food, and the Environment (INRAE) is a public research establishment. It is a community of 12,000 people with more than 200 research units and 42 experimental units located throughout France. The institute is among the world leaders in agricultural and food sciences, in plant and animal sciences, and is 11th in the world in ecology and environment. INRAE's main goal is to be a key player in the transitions necessary to address major global challenges. In the face of the increase in population, climate change, scarcity of resources and decline in biodiversity, the institute develops solutions for multiperformance agriculture, high quality food and sustainable management of resources and ecosystems.

WORKING ENVIRONMENT AND ACTIVITIES

▪ *You will work in the UMR SVQV research unit (UMR-1131 – 'Santé de la Vigne et Qualité du Vin') that associates scientists and technicians from INRAE Colmar and the University of Strasbourg. The main goal of SVQV research unit is to understand the relationships between grapevine and its fungal and viral pathogens – including virus vectors –to develop innovative solutions for a more environmentally friendly viticulture in global warming. The research conducted in the unit is based on complementary expertise in plant pathology, entomology, genetics, genomics and metabolomics. You will be part of the Virology Vection team which focuses more specifically on the (i) development of resistance strategies to the virus responsible of fanleaf disease (Grapevine fanleaf virus, GFLV) and (ii) on the identification of the factors involved in virus transmission by different vectors (nematodes and aphids).*

▪ **Scientific context**

With the pesticide ban in Europe and the recurring emergence of insecticide resistance, the frequency of insect-borne viral diseases in agricultural landscapes is rising sharply. Plant viruses, for which vectors transmit more than 75%, are already responsible for considerable damage in agriculture (~ one-third of economic losses), and their impact is set to increase due to restrictive sanitary measures and global climate change, which favor the spread of insect vectors. In addition, recent studies have shown that viruses can manipulate the phenotype of their host plants (odors, colors, metabolism, etc.) and the behavior of vectors (preference, feeding, dispersal, fitness, etc.) in ways that enhance their transmission, an adaptive mechanism known as "**host and vector manipulation by plant viruses**". Some of the virus components responsible for these effects have been identified, notably in our laboratory (e.g., Chesnais et al., 2021). Conversely, the cellular and molecular determinants in the infected host plant responsible for vector manipulation are still unknown.

To identify the cellular pathways manipulated by viruses in the host plant, transcriptomic studies were recently carried out on *Arabidopsis thaliana* infected with two viruses with different modes of transmission, CaMV (non-circulative virus) and turnip yellows virus (TuYV, circulative virus), both efficiently transmitted by the aphid *Myzus persicae*. The study revealed strong virus-specific signatures (Chesnais et al., 2022), including deregulations that could be responsible for behavioral alterations of aphids on infected plants. Functional validation, necessary to confirm the role of the genes and pathways identified in the manipulation mechanisms, is however unfeasible given the several hundred candidate genes identified by this approach.

The aim of this thesis project is, therefore, to tackle the problem from a new angle. We will exploit the genetic diversity of host plants (a genotyped collection of natural accessions of *A. thaliana*) and take advantage of a **high-throughput video-phenotyping technique of aphid behavior** to identify functional loci (genes or genomic regions) by "**Genome-Wide Association Study**" (GWAS). This combination of techniques

has already been successfully applied to identify resistance genes to the aphid *M. persicae* in Arabidopsis, but has never been used to address the molecular mechanisms underlying viral manipulation and transmission. Compared to transcriptomic analyses, this method will enable unbiased, and more targeted, identification of genes or pathways altered in the host plant infected with TuYV or CaMV and responsible for aphid behaviors that favor viral transmission. We hypothesize that the genes identified in Arabidopsis and the aphid responses will be specific to the viruses' modes of transmission. Functional validation using transgenic Arabidopsis will be carried out on the best candidates to confirm their role in viral manipulation effects. Understanding the molecular basis of this mechanism could contribute to the development of new control methods based on the blockage, or inhibition, of virus transmission, by affecting the vector's behavior on infected plants.

We are looking for a highly motivated student interested in insect vector behavior and plant virology. This fully funded PhD project is part of an ANR JCJC "PHENOMANI" project that is due to start at the end of 2024-early 2025. The selected candidate will benefit from this project's financial support (*i.e.,* experiments, training, conferences…). The PhD student would be based in Colmar supervised by Véronique Brault (https://svqv.colmar.hub.inrae.fr/personnel/braut-veronique) and co-supervised by Quentin Chesnais (https://svqv.colmar.hub.inrae.fr/personnel/chesnais-quentin).

TRAINING AND SKILLS REQUIRED

Master's degree/Engineering degree

- Required training: Master's degree (or degree of equal standing) in Ecology/Agronomy/Virology.
- Knowledge required:

- Basic knowledge on plant-insect interactions and phytopathology;
- Interest in studying insect behavior using new tools (video-tracking);
- Experience in data processing and the use of statistical analysis tools (e.g., R);
- Experience in molecular biology techniques (RT-PCR, cloning, VIGS, etc.) and cellular techniques (microscopy) would be a plus.

The candidate will carry out experiments autonomously under controlled laboratory conditions. The candidate must be curious, meticulous, and have good communication skills (in French and English) to interact effectively with team members.

INRAE'S LIFE QUALITY

By joining our teams, you benefit from (depending on the type of contract):

- until 30 days of annual leave + 15 days "Reduction of Working Time" (for a full time);
- parenting support: CESU childcare, leisure services;
- skills development systems: training, career advise;
- social support: advice and listening, social assistance and loans;
- holiday and leisure services: holiday vouchers, accommodation at preferential rates;
- sports and cultural activities;
- collective catering.

↘ Reception modalities

- Unit: UMR SVQV 1131 (Team 'Virology and Vection')
- Workplace: Centre INRAE Grand Est-Colmar
- Type of contract: PhD
- Duration of the contract: 36 months
- Doctoral school: ED 414 University of Strasbourg
- Starting date: January 2025
- Remuneration: 2200€/month

↘ How to apply

Please provide: (1) a motivation letter with a statement of research interests, skills and experience relevant to the position, (2) a CV, (3) contact details of one or two referees, and (4) copies of previous degrees and transcripts of records.

- By e-mail: quentin.chesnais@inrae.fr and veronique.brault@inrae.fr

✖ Deadline for applications: October, 31st 2024