# MASTER 2 INTERNSHIP OFFER

Study of the involvement of RNA silencing in the success of cross-protection against *Grapevine fanleaf virus* (GFLV) in *Arabidopsis thaliana*

*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 be welcomed in the unit "*Vine Health and Wine Quality Research Unit*" (SVQV), within « *Virology et Vection* » team as part of a final-year internship.

**CONTEXT:**

Viruses represent a major threat to both natural vegetation and cultivated plants. Grapevine fanleaf virus (GFLV, *Nepovirus*, *Secoviridae*), transmitted by the nematode *Xiphinema index*, is considered one of the most damaging viruses of grapevine. It is found in most vineyards worldwide and affects around two-thirds of cultivated plots in France. The infections can cause yield losses of up to 80% per plot, with an estimated economic impact of approximately $1.5 billion per year in France only.

The management of plant viruses relies mainly on prophylactic (preventive) measures which aim at limiting their introduction and spread. Deploying resistant varieties is currently the most effective approach. However, the number of identified antiviral resistance genes remains limited, and such resistances can be rapidly overcome thanks to viral evolution.

**Cross-protection** represents a promising alternative. This biocontrol strategy, based on antagonistic virus-virus interactions, consists of infecting a plant with a less aggressive virus (the primary virus), in order to protect it against a subsequent infection by a related, more aggressive one (the challenge virus). While its effectiveness has been demonstrated in several pathosystems, the underlying mechanisms remain poorly understood. Previous studies suggest that **RNA silencing**, a key antiviral defense pathway, could be involved: the primary infection would induce the production of siRNAs targeting the viral genome, thereby reducing the ability of a closely related, subsequently inoculated virus to establish infection in the plant.

**OBJECTIVES:**

This internship aims at assessing whether RNA silencing is involved in cross-protection against GFLV in *Arabidopsis thaliana*. To determine whether this defense mechanism is involved, cross-protection assays will be carried out in parallel on wild-type plants (controls) and on single, double, or triple mutant lines (e.g., *dcl4*, *dcl2*, *dcl3*, *dcl2/4*, *dcl2/3/4*…), defective for essential components of the siRNA machinery. If time allows, Illumina sequencing of small RNAs (siRNAs and miRNAs) will be performed to compare profiles between cross-protected and non-protected wild-type plants, before and after challenge inoculation.

■ You will be in charge of:

- Prepare viral inocula and mechanically inoculate plants.
- Collect leaf samples at different time points post-inoculation.
- Extract and quantify total RNAs.
- Perform RT-qPCR to quantify viral load of the primary and challenge variants.
- Analyze qPCR data and perform associated statistical analyses.
- *(Optional)* Prepare samples for Illumina sequencing of siRNA and miRNA.

■ Special conditions of activity: Work will be carried out in a biosafety level 2 (BSL-2) laboratory.

## 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.

## TRAINING AND SKILLS REQUIRED

■ Recommended training: Master 2 student or 3rd-year engineering student in plant biology, molecular biology, microbiology, virology, agronomy, biotechnology, or in a related field.

■ Knowledge required: Knowledge of plant–microorganism interactions and a strong interest in plant virology. Skills in molecular biology (RNA extraction, qPCR…), and statistical analysis (R). Good scientific writing skills.

■ Appreciated experience: Experience in molecular biology (RNA extraction, qPCR) and statistical analyses would be appreciated.

■ Skills sought: Ability to work collaboratively in a team and to communicate scientific results.

Please send a motivation letter and CV to Anne.Sicard@inrae.fr and sulyvann.chereau@inrae.fr with the subject line *"Stage_premunition_LastName_FirstName"* before **31/10/2025**.

## ↘ Reception modalities

■ Unit: UMR "*Vine Health and Wine Quality Research Unit*"" (SVQV), « *Virology et Vection* » team

■ Postal code + city: 68000, Colmar
■ Type of contract: Internship
■ Duration of the contract: 6 months
■ Starting date: from January 2026
■ Remuneration: 4,35 €/h

## ↘ How to apply

Send a motivation letter end a CV to :

■ By e-mail: Anne.Sicard@inrae.fr and sulyvann.chereau@inrae.fr

✖ Deadline for applications: **31/10/2025**