

PhD Position

Ecophysiological modeling of plant-nematode interactions. Understanding the origins and consequences of differential plant susceptibility

Starting date: autumn 2022

Duration of contract: 3 years

Location: [M2P2](#) team at [ISA](#) (INRAE, CNRS, Université Côte d'Azur), Sophia Antipolis, France
[BIOCORE](#) team (Inria, INRAE, CNRS-Sorbonne Université), Sophia Antipolis, France

Context

Root-knot nematodes (RKN) of the genus *Meloidogyne spp.* cause considerable yield losses in numerous crops worldwide. Their name comes from the galls (root knots) they induce on the roots of their host during the establishment of their feeding site that enables nematodes to divert plant resources. Plant reaction to parasitism by RKN strongly depends on the plant species and cultivar. Typical symptoms include stunted growth, wilting and deformation of the roots, but strong differences in the extent of damages are observed both within- and between-species. Understanding the origin of these phenotypic differences is a key challenge to design, improve and assess pest control strategies, including the selection of new tolerant cultivars. To study plant–pest interactions, most mathematical models in the literature either focus on the plant physiology and do not consider the pest dynamics, or conversely are based on the pest life cycle but neglect plant physiology and defence response. In this *interdisciplinary PhD project*, we propose to bridge this gap by developing an integrated model of the plant-nematode pathosystem.

Objectives

1. *Development and calibration of a dynamical model describing plant-nematode interactions*
Experimental data collected in the framework of the ArchiNem project (INRAE, 2020-2021), as well as experimental and field data acquired through our partnership with Vilmorin & Cie will be available for model calibration and validation.
2. *Identification of key physiological and architectural traits that impact infestation dynamics*
Under a panel of epidemic and environmental scenarios, quantitative analyses will be conducted to gain a better understanding of plant-nematode feedbacks and to prioritize plant traits that could be targeted by varietal selection.
3. *Long term epidemiological consequences of plant tolerance*
These consequences will be investigated by looking at the multi-seasonal evolution of nematode density in the soil. Potential trade-offs between yield-related and epidemiological objectives will be highlighted and discussed.

Main activities

Generic activities include: literature reading and synthesis, data processing, reporting, paper and thesis manuscript writing, participation and presentation in conferences and workshops, course-taking and teaching in accordance with doctoral school rules.

Specific activities include:

- dynamical model development and analysis
- programming and numerical simulations (using NEF computing cluster at Inria or Azzurra cluster at Université Côte d'Azur)
- parameter estimation (based on genetic algorithms, gradient-derived methods, ABC, etc.)
- global sensitivity analyses
- model selection and model reduction

The PhD student will interact with ISA biologists from the [IPN](#) (Plant-Nematode Interactions) team and partners from seed company [Vilmorin & Cie](#). The student will have the possibility to participate in experiments and data collection.

Skills

Background in applied mathematics or in biology with strong mathematical modelling skills

Required skills:

- dynamical systems (ODE)
- marked interest in biological applications
- experience in programming (Python or/and R)

Recommended skills:

- experience in parameter estimation or/and optimisation
- proficiency in written and spoken English

Remuneration

Pending funding applications – monthly gross salary 1770 €

Benefits package

- Leave: up to 45 days per year
- Possibility of teleworking
- Social security coverage
- Subsidized meals
- Partial reimbursement of public transport costs
- Social, cultural and sports events and activities
- Access to vocational training

Contacts

Send **CV**, **cover letter** and **references** (referee contact details or reference letters) to:

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