

15 PhD positions available in “MiRA”, an Innovative Training Network (ITN) funded by the European Union’s Horizon 2020

15 PhD positions are available at different research institutions and companies in Europe, participating in the Marie Curie ITN “Microbe-induced Resistance to Agricultural pests” (MiRA). **All positions are open from April 1st 2018 or as soon as possible thereafter. Deadline for applications is January 14th 2018.**

Plants are intimately associated with a diversity of beneficial microorganisms in their root zone, some of which can enhance the plant’s resistance to insect pests. Thus, the use of Microbe-induced Resistance (MiR) to reduce pest losses in agriculture has emerged as a promising possibility to improve crop resilience and reduce use of harmful pesticides. European companies have therefore started to develop and market beneficial microbes. However, MiR appears to be strongly context dependent, with reduced benefits under certain biotic and abiotic conditions and in some crop varieties. Further, it is a challenge to deliver and ensure stable associations of beneficial microbes and plants, and avoid undesired effects on beneficial insects. Thus we absolutely must improve our understanding of MiR mechanisms and context-dependency, in order to improve context stability of MiR and promote the use of MiR for crop protection. The MiRA project will train early stage researchers in basic and applied research on context-dependency of MiR, mechanisms, and impacts on plant performance and other biocontrol organisms, and use this understanding to improve our ability to predict the effectiveness of MiR under different conditions, to select plant and microbial strains with improved context-stability, and to develop better methods for the formulation of microbial inoculants and their application in agriculture. Finally, we will analyse economic prospects and constraints for MiR development and use. We have assembled a consortium of academic institutions and companies, including microbial inoculant producers and agricultural advisors. Our ESRs will be trained within this multi-sectoral interdisciplinary network for a future career in research, product and service development in European horticulture and agriculture, pushing boundaries in European research and innovation. Read more about MiRA at www.miraitn.eu or www.mira.ku.dk.

General requirements for all ESR positions

At the time of commencement, it is required that the candidates have not been awarded a doctorate degree and are within the first 4 years (full-time equivalent) of their research careers. Furthermore, the candidates **must not** have resided or carried out their main activity (work, studies, etc.) in the enrollment country for more than 12 months in the 3 years immediately prior to their recruitment. Short stays, such as holidays, are not taken into account. Candidates are required to spend part of their project period at other institutions in the the MiRA consortium on secondments, see details at individual posts.

PhD scholarship in Plant-Microbe-Insect Ecology (ESR 1)

Ecological Sciences, The James Hutton Institute, Dundee, UK and Department of Plant and Environmental Sciences, University of Newcastle, UK

Project title: Does plant osmotic stress alter microbe-induced resistance to aphids in *Solanum*?

The project aims to explore the potential benefits of plant associations with arbuscular mycorrhizal (AM) fungi for reducing plant susceptibility to insect pests. The project will conduct experiments to disentangle the effects of plant and insect genotypic variation and plant osmotic stress on the strength of AM fungal-induced indirect plant defences, and deduce its potential contribution to pest control in agricultural systems. The position will involve microbe characterisation (AM fungi, insect endosymbionts) and functional analysis of insect and plant microbial symbionts (using measures of plant and insect performance and insect behaviour) within the context of understanding the ecology of agroecosystems. Candidates should have a strong background in plant, microbe and/or insect ecology and experimentation.

Principal supervisor: Alison Karley. E-mail: Alison.Karley@hutton.ac.uk. Phone: +44 (0)1382 568820.

Planned secondments: seven months total in France, USA and Scotland.

Please find the full job advertisement at <https://www.cloudonlinerecruitment.co.uk/jameshutton/>. Please note that only electronic applications are accepted.

PhD scholarship in plant-Microbe-Insect Ecology (ESR 2)

Functional Ecology Laboratory, Institute of Biology, University of Neuchâtel

Project title: Effects of eco-climatic adaptation of tomato and microbe genotypes on resistance-induction

The aim of the project is to test the effect of plant and mycorrhizal (MO) genotypic variation on plant direct and indirect defences against insect pests. The experiments will involve exposing different genotypes of MO in combination to several tomato cultivars with known biogeographical origin in order to extract information about MiR variability across different climate-adaptations. Methods will include evaluation of plant direct defenses (secondary metabolite and phytohormone expression, pest performance), and indirect defenses (volatile organic compound production, parasitoid recruitment) across different genotype-by-genotype interactions. Results will be integrated with parallel experiments done by other ESRs to evaluate context dependency of microbe-induced plant resistance and will serve the bases for the identification of the optimal plant-MOs genotypic combination for increased plant resistance against insect pests.

Principal supervisor: Sergio Rasmann, E-mail: sergio.rasmann@unine.ch Phone: +41 (0)32 718 23 37, mobile: +41 (0)76 507 08 76.

Planned secondments: eight months total in Spain and Germany

Please find the full job advertisement at <https://www.unine.ch/lef/home.html>

PhD scholarship in Plant-Microbe-Insect Ecology (ESR 3)

Insect Biology Research Institute (IRBI), National Center for Scientific Research / University of Tours

Project title: Impact of plant-associated Arbuscular Mycorrhizal Fungi (AMF) on insect endosymbionts and consequences for resistance-induction and performance of tomato

The aim of the project is to test whether plant-associated microorganisms affect insect symbionts and insect performance as herbivores. The position will involve i) experiments with combinations of plants, microbes and insect pests, ii) identification of microbial communities associated with insects exposed to plants with or without AM fungi and iii) evaluation of plant resistance (plant hormone and metabolite induction) and pest performance. Results will be integrated with parallel experiments done by other Early-Stage Researchers (ESRs) to evaluate context dependency of microbe-induced plant resistance. Candidates should have a strong background in plant, microbe and/or insect ecology and solid knowledge in molecular biology / bioinformatics.

Principal supervisor: David GIRON. E-mail: david.giron@univ-tours.fr Phone: +33 2 47 36 69 11, mobile: +33 6 62 21 43 82.

Planned secondments: six months total in Spain

Please find the full job advertisement at <http://irbi.univ-tours.fr> . Only electronic applications are accepted.

PhD scholarship in Plant-Microbe-Insect ecology (ESR 4)

Department of Plant and Environmental Sciences, University of Copenhagen, Denmark

Project title: Effect of phytopathogens and entomopathogens on microbe-induced plant resistance and performance

The aim of the project is to test if beneficial effects for plants of having associations with resistance-inducing microbes in the root zone is moderated by simultaneous infection by plant pathogens and root-associated

insect-pathogens. The position will involve experiments with combinations of plants, microbes and insects, and evaluation of plant, microbe and pest performance (plant hormone and metabolite induction, plant growth, biomass, seed production, microbe colonisation, pest consumption and growth, etc.). Results will be integrated with parallel experiments done by other ESRs to evaluate context dependency of microbe-induced plant resistance. Candidates should have a strong background in plant, microbe and/or insect ecology and experimentation.

Principal supervisor: Thure P Hauser. E-mail: tpha@plen.ku.dk. Phone: +45 3533 2818.
Planned secondments: five month total in Germany and Netherlands.

Please find the full job advertisement at <http://employment.ku.dk/>. Only electronic applications are accepted.

PhD scholarship in Plant-Microbe-Insect interactions (ESR 5)

Department of Microbial Ecology, Netherlands Institute of Ecology (NIOO-KNAW), Wageningen, NL

Project title: Impact of microbial inoculums on microbiome composition and resistance-induction of host plants against insect pests

The aim of the project is to determine the impact of rhizosphere microbial community and microbial volatiles on efficacy of induced systemic resistance against insect pests. By applying state-of-the-art genomic, transcriptomic and metabolomics methods we will explore the mechanisms underlying the microbe-induced resistance against pests. Results will be integrated with parallel experiments done by another ESR to evaluate whether microbial inoculants can be used to enhance plant defence without impeding the efficacy of insect biocontrol agents. Candidates should have a strong background in plant, microbe and/or insect ecology and experimentation.

Principal supervisor: Paolina Garbeva, Email p.garbeva@nioo.knaw.nl Phone +31 (0)317-473492
Planned secondments: Five months total in Spain and Netherlands

Please find the full job advertisement at <https://nioo.knaw.nl/nl/vacatures-en-stages> . Only electronic applications are accepted.

PhD scholarship in -Plant Microbe Insect Interactions (ESR 6)

Department of Soil Microbiology and Symbiotic Systems, Estación Experimental del Zaidín, Spanish National Research Council (CSIC), Granada, Spain

Project title: Signaling in induced resistance modulation by beneficial soil fungi (AMF/*Trichoderma*) against chewing and sucking insects in tomato

The aim of the project is to determinate the main defense signalling pathways mediating the impact of beneficial soil fungi (arbuscular mycorrhizal (AM) fungi and *Trichoderma* spp) on insect pests in tomato plants, and how the abiotic context (drought, light, nutrient availability) shape the interactions. The position will involve experiments aimed to characterize the range of effectiveness of soil borne-induced resistance on insect herbivores, the signals involved in the process and how different abiotic factors affect the production and transport of the signals. Results will be integrated with parallel experiments done by other ESRs to evaluate context dependency of microbe-induced plant resistance. Candidates should have a strong background in plant physiology, plant biotic interactions and preferably experience in plant biochemistry and/or molecular biology, soil microorganisms, and/or insect experimentation.

Principal supervisor: Maria J. Pozo. E-mail: mjpozo@eez.csic.es. Phone: +34958181600
Planned secondments: ten month total in Denmark, Netherlands and Spain

Please find the full job advertisement at <http://www.eez.csic.es/ofertas-y-convocatorias-de-empleo-y-formacion>. Only electronic applications are accepted.

PhD scholarship in Plant-microbe-insect interactions (ESR 7)
Department of Biology, Utrecht University, the Netherlands

Project title: Molecular mechanisms underlying interactions between microbe-induced resistance to herbivorous insects and pathogenic microbes

The aim of the project is to get insight into the molecular mechanisms that underlie the complex interplay between plant signalling pathways that are induced in tomato plants by diverse simultaneous triggers, namely (i) beneficial rhizobacteria (*Pseudomonas* spp) that enhance plant resistance to pests and diseases, (ii) herbivorous insects, (iii) pathogenic microbes, and (iv) different abiotic contexts (drought, shading). An RNA-Seq-based transcriptomic approach is followed to study modulation of beneficial microbe-primed defences when plants are attacked by insects, whether or not in combination with other stressors. This will reveal signal integrative hubs, which together with hormone and metabolome data, will increase our understanding of how primed plants regulate their immune system under diverse conditions. Results will be integrated with existing data sets, mostly of Arabidopsis, which are available in the lab, and with parallel experiments done by other ESRs to evaluate the context dependency of microbe-induced plant resistance. Candidates should have a strong background in plant molecular biology, plant-microbe/insect interactions and preferably experience with programming and bioinformatics.

Principal supervisor: Saskia van Wees. E-mail: s.vanwees@uu.nl. Phone: +31 30 253 6861.

Planned secondments: Eight months total in Denmark, Germany and the Netherlands.

Please find the full job advertisement [here](#). Only electronic applications are accepted.

PhD scholarship in Molecular Interaction Ecology of Plant-Microbe-Insect Interactions (ESR 8)
German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig & Friedrich-Schiller-University Jena

Project title: An integrated "omics" approach to unravel the impact of root symbionts on tomato direct and indirect defenses against herbivores

The aim of this PhD project is to assess the modulation of tomato defence responses by beneficial soil fungi, particularly arbuscular mycorrhizal fungi (AMF) and *Trichoderma* spp, and assess their impact on the performance of aboveground chewing and sucking insect pests as well as their natural enemies. Using a combination of metabolomics and transcriptomic approaches, the molecular and chemical mechanisms underlying MiR will be studied on different lines of tomato plants grown under controlled conditions. These analyses will be complemented with assays on insect performance and behaviour that can be directly related to microbe-induced changes in volatile and non-volatile metabolomes. With this integrative "omics" approach, spanning from gene expression to metabolite accumulation, we will obtain a broader view on the biological mechanisms involved in MiR and assess its ecological consequences up to the third trophic level.

Principal supervisor: Prof Dr Nicole M. van Dam (nicole.vandam@idiv.de) and Dr Ainhoa Martinez-Medina (ainhoa_martinez.medina@idiv.de), telephone: +49-341-9733166 (secretariat).

Planned secondments: six months total in Denmark and Spain

Please find the full job advertisement at https://www.idiv.de/about_idiv/career.html Only electronic applications are accepted.

PhD scholarship in - Plant Microbe Insect interactions (ESR 9)
Department of Plant and Environmental Sciences, University of Copenhagen, Denmark

Project title: Impact of drought on plant resource allocation and its effect on intra and inter-organismal signalling between resistance-inducing rhizosphere bacteria and plant

The aim of the project is to obtain mechanistic understanding of the interactions between tomato plants and beneficial *Pseudomonas* strains. *Pseudomonas* strains produce lipopeptides, volatiles and plant hormones,

which are involved in antagonism against plant pathogens and probably MiR. The central hypothesis is that that bacterial biofilm formation and metabolite production contribute to the improved tolerance of the plant through regulation of primary carbohydrate metabolism and direct activation of plant defense responses. The project will address (1) the effects of drought on root colonization, biofilm formation and production of lipopeptides and plant hormones, (2) the contribution of resource allocation to abiotic stress and insect pest resilience and (3) the role of phytohormones produced by the plants and by beneficial microbes in coordinating plant primary and secondary metabolism in response to abiotic stress and insect pests.

Principal supervisor: Professor Thomas Roitsch, roitsch@plen.ku.dk, Phone: +45 3533 1526 and Associate Professor Ole Nybroe, oln@plen.ku.dk, , Phone: +45 3533 26 29.

Planned secondments: Eight months total in Scotland, the Netherlands and Germany.

Please find the full job advertisement at <http://employment.ku.dk/>. Only electronic applications are accepted.

PhD scholarship in Ecology of Plant-Microbe-Insect Interactions (ESR 10)

Department of Environmental Protection, Estación Experimental del Zaidín (EEZ), Spanish Council for Scientific Research (CSIC), Granada, Spain.

Project title: Effect of resistance-inducing mycorrhiza on natural enemies of aphids in tomato

The aim of the project is to determinate the role of arbuscular mycorrhizal (AM) fungi in inducing both direct and indirect plant defences in tomato plants, assessing the tri-trophic role of microbes-induced resistance on bottom-up regulation of herbivores. The position will involve experiments aimed to characterize the hormonal signal routes mediating microbes-induced resistance in different tomato lines and the plant-mediated effects of below-ground AM fungi on third trophic level organisms (biocontrol agents) and their aphid prey. Results will be integrated with parallel experiments done by other ESRs to evaluate context dependency of microbe-induced plant resistance. Candidates should have a strong background in plant, soil microorganisms, and/or insect ecology and experimentation.

Principal supervisor: Emilio Benítez E-mail:emilio.benitez@eez.csic.es. Phone: +34 958181600.

Planned secondments: ten months total in Netherlands and Switzerland.

Please find the full job advertisement at <http://www.eez.csic.es/ofertas-y-convocatorias-de-empleo-y-formacion>. Only electronic applications are accepted.

PhD scholarship in - Plant-Microbe-Insect Ecology (ESR 11)

Department of Terrestrial Ecology, Netherlands Institute of Ecology (NIOO-KNAW), Wageningen, The Netherlands

Project title: Abiotic modulation of effects of mycorrhizae on plant indirect and direct defence against insect pests

The aim of the project is to study how the effects of beneficial microbes (arbuscular mycorrhizal fungi) on insect pests and their natural enemies are modified by the abiotic environment. Plants and mycorrhizal strains will be grown under different light and soil phosphorus conditions to evaluate effects on plant and herbivore performance, plant biochemistry, herbivore-induced plant volatiles, and the attraction and performance of the natural enemies of the herbivores. Results will be integrated with parallel experiments done by another ESR to evaluate whether microbial inoculants can be used to enhance plant defence without impeding the efficacy of insect biocontrol agents. Candidates should have a strong background in plant, microbe and/or insect ecology and experimentation.

Principal supervisor: Dr. Arjen Biere, E-mail: a.biere@nioo.knaw.nl. Phone: +31 317 47 3611.

Planned secondments: nine month total in Denmark, Switzerland and Spain.

Please find the full job advertisement at <https://nioo.knaw.nl/en/job-vacancies-and-internships>. Only electronic applications are accepted.

PhD scholarship in - Plant-Microbe-Insect Ecology (ESR 12)
INOQ GmbH, Schnega, Germany

Project title: Using insects as vectors for inoculation of beneficial resistance-inducing microbes in plants

Different insect species must be tested for their ability as vectors for the integration of resistance-inducing microbes such as fungal and bacterial endophytes into host plants. Phloem-sucking and leaf-chewing insect species must be bred, fungal and bacterial endophytes propagated and in experiments with host plants investigated if insects have the ability to transfer resistance-inducing microbes into host plants. A production system for the insect vectors should be developed as well as a transfer-system for the resistance-inducing microbes. Tracing of the microbes in the host plant is necessary as well as the proof of efficiency for resistance induction. Results will be integrated with parallel experiments done by other ESRs to evaluate context dependency of microbe-induced plant resistance. Candidates should have a strong background in plant, microbe and/or insect ecology and experimentation.

Principal supervisor: Imke Hutter E-mail: hutter@inoq.de Phone: +49 (0)5842 981 672

Planned secondments: ten months total in France, Netherlands, and Germany.

Please find the full job advertisement at www.inoq.de Only electronic applications are accepted.

PhD scholarships in Plant-Microbe-Insect Interactions (ESR 13)
Department of R&D Microbiology, Koppert Biological Systems, Berkel en Rodenrijs, The Netherlands

Project title: The study of soil borne beneficial microbial consortia to contribute to the research on plant protection products for modern agriculture.

Main aspects of study:

- Molecular identification of model microbes (*Trichoderma Harzianum* T22, ISR inducing rhizobacteria, and arbuscular mycorrhizal fungi)
- Assemblage of potentially complementary species with high potential for indirect (ISR) and direct (mycoparasitism, antibiosis) pest and disease control, and crop performance e.g. growth, yield.
- Exploring the effects of commonly occurring biotic and abiotic factors under production on the performance of the consortia
- Evaluation of the consortia under commercial conditions

Principal supervisor: Dr. Roxina Soler, Koppert, rsoler@koppert.nl, phone +31630765439; Dr. Maria J. Pozo, Senior research Scientist, CSIC (Granada, Spain) and Associated Professor at the PhD program from Granada University.

Planned secondments: 10 months of secondments in Spain, The Netherlands and Germany.

Please find the full job advertisement at <https://koppert.has-jobs.com/>, Only electronic applications are accepted.

PhD scholarship in Applications of Plant-Fungi-Insect Interactions (ESR 14)
Department of Plant and Environmental Sciences, University of Copenhagen, Denmark

Project title: Resistance-inducing benefits from root-associated entomopathogens: translation from lab observations to field application

The aim of this project is to elucidate how root-associated entomopathogenic fungi (fungi that can infect insects) affect plant resistance and how they co-exist with arbuscular mycorrhizal fungi (AMF). This will be

done by comparing the effects of root/rhizosphere colonizing fungi (entomopathogenic vs AMF) on resistance-induction, plant performance, below- and above-ground herbivores, when applied individually and in combination. Establishment efficiency of entomopathogenic fungi in the rhizosphere will be evaluated under variable growth conditions (abiotic effects) and in competition with other microbes (biotic effects) in lab and field situations to identify potential constraints for obtaining reliable efficacy under field conditions. Candidates should have a strong background in plant, microbe and/or insect ecology and experience in conducting experiments.

Principal supervisor: Associate Prof Nicolai V Meyling, nvm@plen.ku.dk, Phone: +45 3533 2666 and Associate Prof Thure P Hauser, tpha@plen.ku.dk, Phone: +45 3533 2818.
Planned secondments: 10 months total in Spain

Please find the full job advertisement at <http://employment.ku.dk/>. Only electronic applications are accepted.

PhD position in Research on Acceptance of Innovations in Agriculture (ESR 15)
Department of Department of Agricultural and Food Market Research, University of Bonn, Germany

Project title: Multi-Stakeholder acceptance of using beneficial soil microbes for crop yield and pest suppression in tomato and potato cultivation in Europe

The aim of the project is twofold: (1) to assess consumers' awareness, attitudes and acceptance of the use of soil microbes for pest suppression and to identify whether and to what extent consumers are able to differentiate this type of biotechnology from others (e.g. GMOs). (2) to assess farmers' awareness with respect to soil microbes for pest suppression and to evaluate the impact of information on farmers' perception of main benefits and obstacles as well as their attitudes and willingness to make use of it.

The results of the project will contribute to adjust theories and to develop methods to evaluate farmers' and consumers' acceptance regarding the use of resistance-inducing microbial products and methods in European agriculture. Moreover it will help to understand consumers' and farmers' acceptance and derive recommendations to support the dissemination this new technology.

Principal supervisor: Prof Monika Hartmann. Monika.hartmann@ilr.uni-bonn.de. Phone: +49 228 73 35 38.
Planned secondments: 6 months total in Germany, Spain and United Kingdom.

Please find the full job advertisement at http://www.ilr.uni-bonn.de/central/jobs_d.htm. Only electronic applications are accepted.
