Multiomics approaches for the control of plant-parasitic nematodes

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Cláudia Vicente

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ENCONTRO COM A CIÊNCIA E TECNOLOGIA EM PORTUGAL

16 a 18 MAIO 2022

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CHANGE

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25 years of Nemalab (Nematology Lab, MED-UE) – major research lines

Manuel Mota, PhD

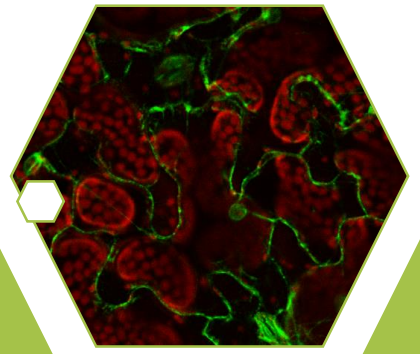
Cláudia Vicente,
PhD – CEEC'18

Margarida Espada,
PhD – CEEC'18

Carlos G.Gutiérrez,
PhD DL57/16

Pedro Barbosa,
FCT PhD student

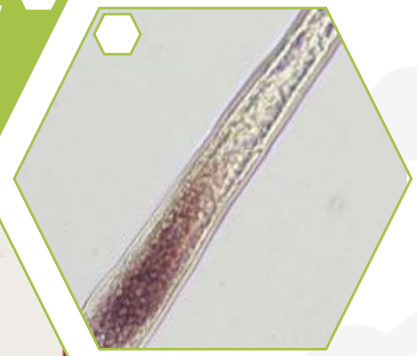
David Pires,
FCT PhD Student



Taxonomy and phylogeny

Biocontrol and phytochemistry

Plant-nematode interactions



Nematode-microbe interactions

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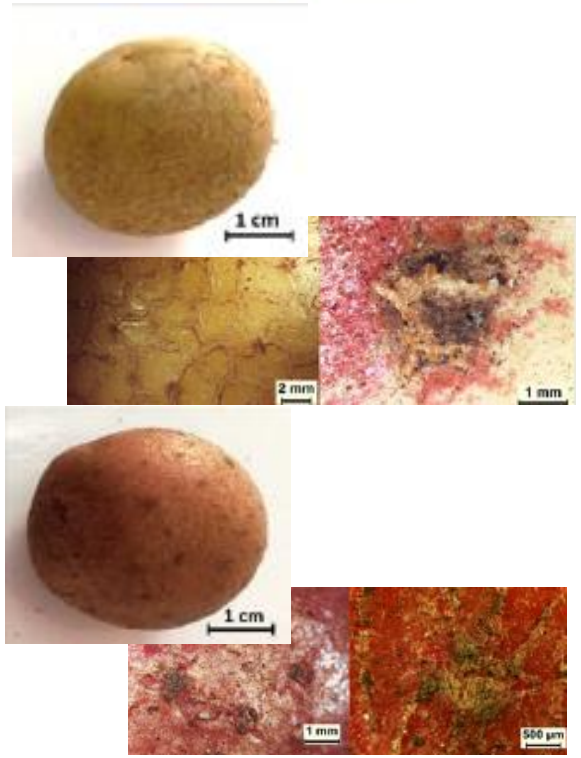
Plant-parasitic nematodes of interest

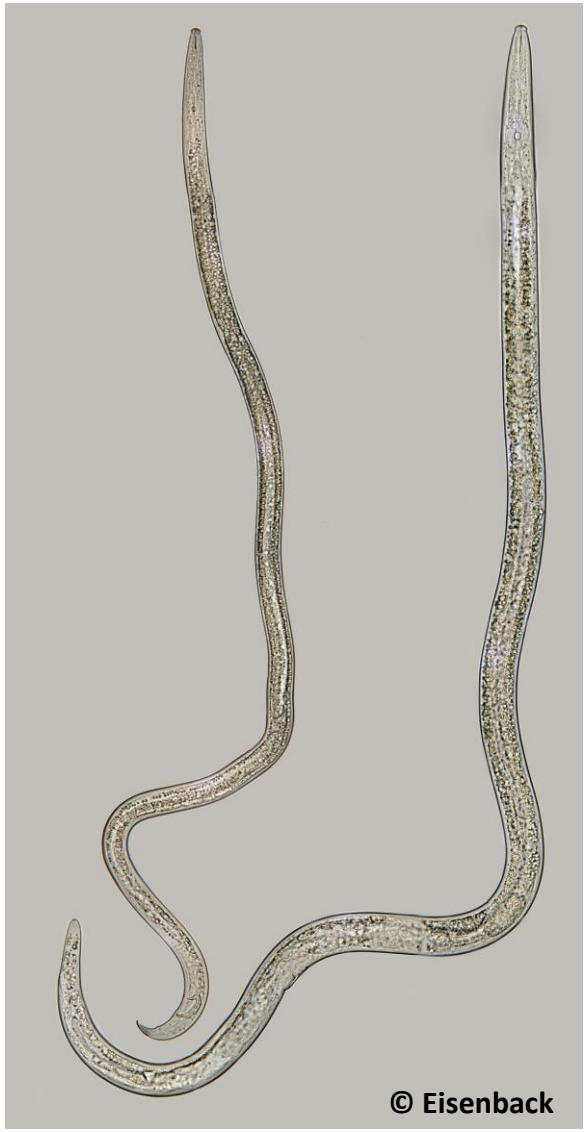
Root-lesion Nematodes

Pratylenchus penetrans



Figueiredo et al., 2021, Plant Pathol. 1-9

Pinewood Nematode



Bursaphelenchus xylophilus

Biotechnological approaches for the control of the root-lesion nematode *Pratylenchus penetrans*

Manuel Mota, PI

Paulo Vieira, co-PI

MAIN GOALS

- Study of the **molecular mechanisms** involved in the parasitism of *Pratylenchus penetrans* for the development new and species-specific strategies of control
- Generation of *Pratylenchus penetrans* **transcriptome infecting potato plants**
- Application of **silencing methodologies (RNAi soaking and *in planta* RNAi**) for the knock-down of target genes of *P. penetrans* involved in nematode-plant interaction

FCT funding: 199.555,20€

Proponent Institute

Partner 1

Partner 2

Plant metabolomics for the control of the root-lesion nematode *Pratylenchus penetrans*

@PratyOmics

Cláudia Vicente, PI

Maria de Lurdes Inácio, co- PI
INIAV

MAIN GOALS

- **Metabolome** comparison between **resistant** and **susceptible** potato cultivars in response to *P. penetrans* infection for the identification of resistant-related metabolites (e.g., plant secondary metabolites)
- **Bioactivity evaluation of secondary metabolites** in *P. penetrans*
- Study the **mode of action** of the most promising secondary metabolites in the **control** of *P. penetrans*

Proponent Institute

Partner 1

Partner 2

Consultants

FCT funding: 249.936,90€

A *motif* to unveil mechanisms of parasitism gene regulation in the pinewood nematode as a target for disease control and plant resistance.

Margarida Espada, PI

Manuel Mota, co-PI

How is parasitism regulated?

MAIN GOALS

- Identify **transcription regulators** that are associated with secreted **parasitism-related genes**;
- Identify the **protein complexes that bind to non-coding DNA motif**
- **Knock-down** (RNAi) candidate regulators and evaluate the effect in nematode parasitism-related genes
- *In planta*: evaluate the effect of **knock-down or over-expression** of the regulators in nematode parasitism

FCT funding: 249.439,00€

Proponent Institute

Partner

Consultants

Plant metabolomics for the control of the root-lesion nematode *Pratylenchus penetrans*

Cláudia Vicente[1,3]*, Jorge Faria[1], Dora Teixeira[2], Paulo Vieira[3], Margarida Espada[3], Pedro Barbosa[3], Manuel Mota[3], Joana Figueiredo[4], Joana Sá Cardoso[4], Ivânia Esteves[4], Isabel Abrantes[4], Rita Varela[1], Filomena Nóbrega[1],Maria de Lurdes Inácio[1]

[1]INIAV I.P. - Instituto Nacional de Investigação Agrária e Veterinária, Oeiras, Portugal
[2]HERCULES – Herança Cultural, Estudos e Salvaguarda, Universidade de Évora, Évora, Portugal
[3]MED – Instituto Mediterrâneo para a Agricultura, Ambiente e Desenvolvimento, Universidade de Évora, Évora, Portugal
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Pratylenchus penetrans, one of the most detrimental root-lesion nematode species, greatly reduces the production in numerous important agronomic crops (e.g., corn, potato), ornamental plants (e.g., lily, roses) and fruit trees (e.g., almond, cherry orchards). In the EU, *P. penetrans* has been reported as the most damaging species associated with potato (*Solanum tuberosum* L.). In Portugal, this species was also detected in potato production fields across the country and often related with their low yield.

Plant metabolomics is an emerging approach to the study crop resistance against plant-parasitic nematodes, which can be applied to expedite traditional crop breeding programs and the development of novel pesticides.

PratyOmics

- Potato Inoculation trials with *Pratylenchus penetrans*
- Plant metabolic profilling in response to *Pratylenchus penetrans*
- *In vitro* screening of plant-derived compounds for nematicidal action
- Transcriptome of *Pratylenchus penetrans* treated with plant-derived compounds

PratyOmics aims:

(i) to compare global metabolomic profiling of resistant and susceptible potato cultivars in response to *P. penetrans* infection for the identification of host resistant-induced plant secondary metabolites (PSM) with potential anti-nematode activity;

(ii) to evaluate the nematicidal bioactivity of the candidate PSM against *P. penetrans*; and

(iii) to understand the mechanism of action of the most promising PSM by transcription profiling of nematode affected nematode molecular pathways, which can be translated into targets for the **development of new effective nematode control strategies.**

PratyOmics (PTDC/ASP-PLA/0197/2020) is funded by Fundação para a Ciência e Tecnologia.

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NemaWAARS

Unveil mechanisms of parasitism gene regulation in the plant-parasitic nematode *Bursaphelenchus xylophilus*, as a target for disease control and plant resistance.

Margarida Espada[1], Cláudia Vicente[1], Jorge Faria[2], Pedro Barbosa[1], Isabel Velada[1], Margarida Santos[2], Filomena Nóbrega[2], Paulo Vieira[3], Sebastian Eves-van den Akker[4], Maria de Lurdes Inácio[2], Manuel Mota[1]

[1]NemaLab-MED – Mediterranean Institute for Agriculture, Environment and Development, Institute for Advanced Studies and Research, Universidade de Évora, Pólo da Mitra, Évora, Portugal | [2]Nematology Lab-INIAV – Instituto Nacional de Investigação Agrária e Veterinária, Oeiras, Portugal | [3]United States Department of Agriculture (USDA), Agricultural Research Services (ARS), Mycology & Nematology Genetic Diversity & Biology Lab, Beltsville, MD 20705, USA | [4]Department of Plant Sciences, University of Cambridge, Cambridge, United Kingdom

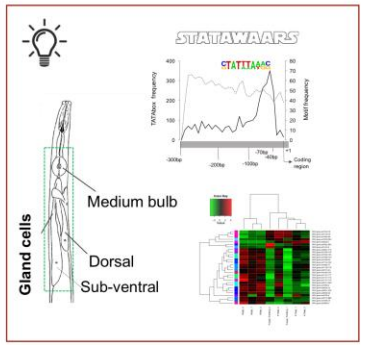

Figure 1 | Concept idea of NemaWAARS (Espada *et al.*, 2018; Eves van-den Akker *et al.*, 2016)

The interaction of plant-parasitic nematodes (PPN) with their plant hosts are mediated by parasitism proteins (effectors) that interact and/or modify host proteins to promote infection. NemaWAARS project focuses on mechanism(s) of regulation and gene control expression of parasitism genes of the migratory endoparasite *Bursaphelenchus xylophilus* (the pinewood nematode). Supported by genomic and transcriptomic data previously established for this pathogen we have identified a DNA motif - STATAWAARS - associated in the promotor region of secreted pharyngeal gland cells coding effector genes. Given that this non-coding genetic signature unifies many sequences of unrelated effectors, it implies the existence of a potential major regulator(s), that binds to this sequence to orchestrate the expression of downstream effector genes. A similar master regulator has been recently proposed for other PPNs (Tylenchida) non-related to migratory nematodes or to this clade of nematodes (Aphelenchida). We hypothesize that by disrupting this regulator(s), it would be possible to simultaneously disrupt the expression of a large number of associated effector genes. This could be a new attractive target for host induced gene silencing, as switching-off the regulator of numerous effectors at the same time, can reduce and inhibit the performance of this parasitic nematode. This project aims to identify transcription regulators associated with this motif and understand the impact of silencing enriched gland cells transcription factors on the PWN interaction with the host. The strategy in NemaWAARS will include innovative approaches to develop a better understanding of how the effectors are regulated, their function in the cell host and use their sequences as potential targets for genetic editing towards an effective nematode resistance in the plant. The ability to explore host-delivered mechanisms against the pathogens could have a tremendous impact as biotechnology standpoint in important forestry species.

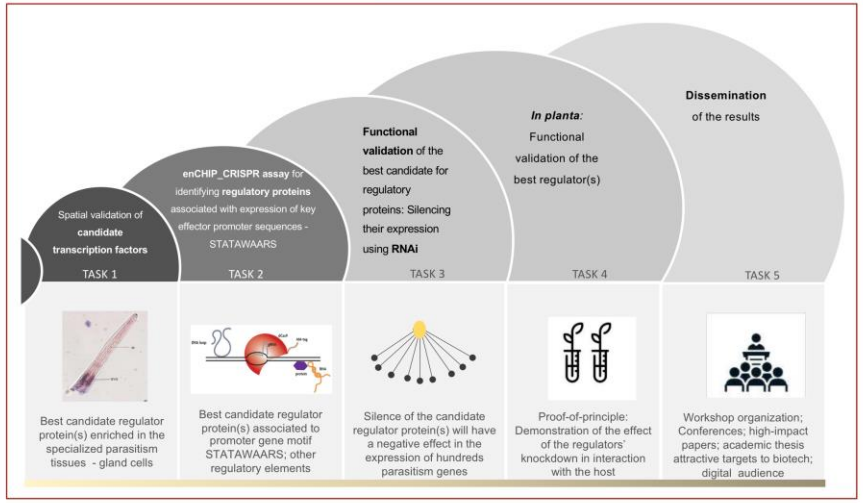

Figure 2 | Workflow of NemaWAARS project

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Our collaborations

Maria de Lurdes Inácio
Jorge Faria
Marina Costa

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Ivânia Esteves
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Joana Figueiredo

Dora Teixeira

Paulo Vieira
Lev G. Nemchinov

Sebastian Eves-van den Akker

Ana C. Figueiredo

Fátima Duarte
Teresa Brás

Thank you!

www.med.uevora.pt