Root exudates as new biocontrol products against phytoparasitic nematodes

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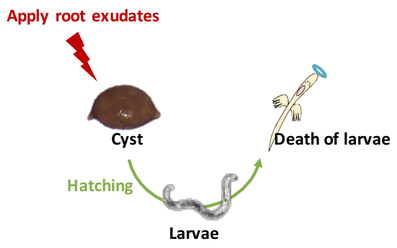
Social-economic context

Plant-parasitic nematodes are among the most harmful pathogens of cultivated crops. Economic losses due to nematodes have been estimated at more than $US 100 billion at the world scale.
The intensive use of pesticides in agriculture, such as nematicides for controlling nematodes, has led to a significant proportion of pesticide residues in environment. Nowadays, environmental and human health problems are the main concerns of the society and governments which results in the restriction of the use of many chemicals products. This encourages the emerging of new alternative solutions in agriculture, such as the use of biocontrol.

Scientific context



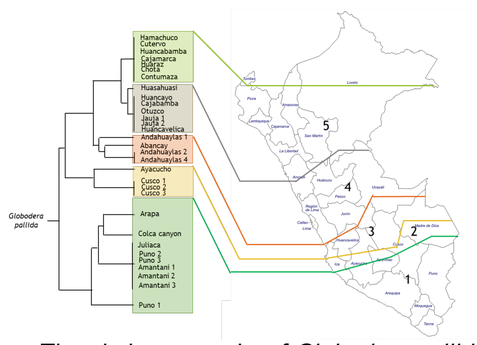
The rule of « suicide hatching »

In many cysts nematode species, the hatching, which is the first step of the development cycle, is mainly dependant and stimulated by **root exudates** released by the host plant into the rhizosphere. Root exudates includes amino acids, organic acids, sugars, phenolics, mucilage, proteins and other secondary metabolites, which contains specific compounds know as **hatching factors**. If these chemical compounds can be identified, they would constitute an effective and innovative **biocontrol method** that could be used in the absence of the host plant and called **"suicide hatching**".

Objectives

The general purpose of this thesis is to study the hatching dynamics of three nematode species: *Globodera pallida*, *Heterodera schachtii* and *Heterodera carotae*. To anticipate the effectiveness of root exudates, different environments will be tested by varying the parameters such as the genetic diversity of nematodes and the microbiotic composition in soil.
This subject is organized along three major tasks:

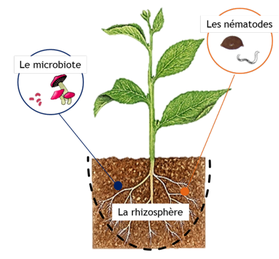
- **Testing for coevolution between plants and nematodes for the hatching traits?** The phylogeography in Peru of both *Solanum* species and *Globodera* species is well known and thus supposed that both plants and nematodes have coevolved together in this region. To test this hypothesis, root exudates from 15 species of wild *Solanum* natives from Peru will be tested for their hatching abilities against 15 populations of *Globodera pallida* from the same country.



The phylogeography of *Globodera pallida*

- **Effectiveness of root exudates according to the genetic diversity of *G. pallida, H. schachtii* and *H. carotae*.** After a screening of root exudates from different plant species, those maximizing the hatching level will be tested against representative populations of the genetic diversity for these 3 nematodes at different geographical scales (Worldwide, European and national, respectively). The structuration of the genetic diversity is well known for *H. schachtii* and *G. pallida* instead of *H. caratoe* for which microsatellite markers have been developed in order to investigate it. These results will enable an anticipation of the spatial efficiency of root exudates.

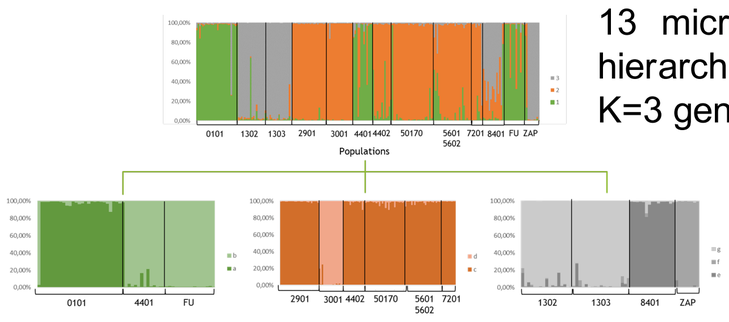
- **Microbiote effect on the quality and efficiency of root exudates.** To evaluate the influence of micobiote on the quality of root exudates, potatoes' exudates will be produced in soil differing by their microbiotic composition. These exudates will be then tested for their hatching abilities on one *G. pallida* population.



Tritrophic interactions

Results

In order to study the genetic structuration of *H. carotae* populations, a Bayesian clustering analysis was performed on 230 individuals coming from 14 populations sampled in France, Switzerland and Italy and genotyped for the 13 microsatellite markers that have been developed. The highest level of hierarchical structuration of populations is best explained with a grouping into K=3 genetic clusters.



Clustering results of *Heterodera carotae* individuals

Within each cluster, another analysis had been realised and showed the existence of a sub-structuring. All populations are grouped into 7 sub-clustering. This suggests that root exudates should be evaluated against 7 different populations, each coming from one different sub-cluster to take account of the genetic diversity of the species.

Perspectives

A good knowledge about the spatial structuration of genetic diversity is essential to develop new sustainable biocontrol solution for controlling plant-parasitic nematodes. An expertise of the impact of micobiotic composition in soil on the root exudates degradation will help to anticipate their spatial effectiveness.

Keywords
Cyst nematodes
Coevolution
Suicide hatching
Hatching factors
Miciobiote