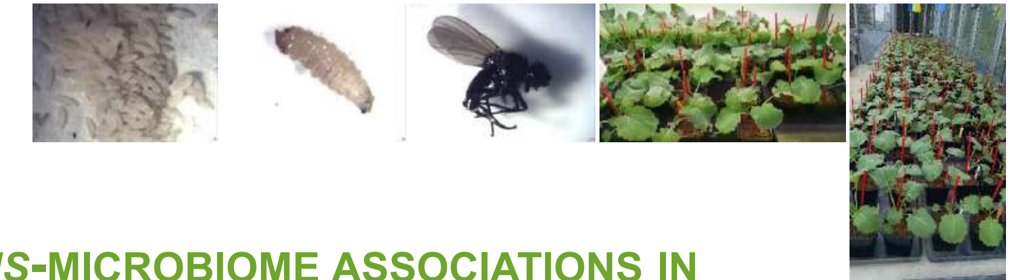
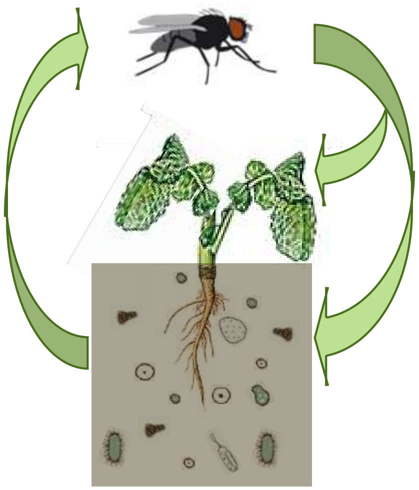


DECIPHERING *BRASSICA NAPUS*-MICROBIOME ASSOCIATIONS IN INTERACTION WITH ROOT HERBIVOROUS INSECT *DELIA RADICUM*: A FEEDBACK LOOP IN THE RHIZOSPHERE



Ourry Morgane, Lebreton L., Chaminade V., Guillerm-Erckelboudt A.Y., Hervé M., Linglin J., Marnet N., Ourry A., Paty C., Poinsot D., **Cortesero Anne Marie, Mougel Christophe**

Institute for Genetics, Environment and Plant Protection Rennes

IGEPP Institut de Génétique, Environnement et Protection des Plantes

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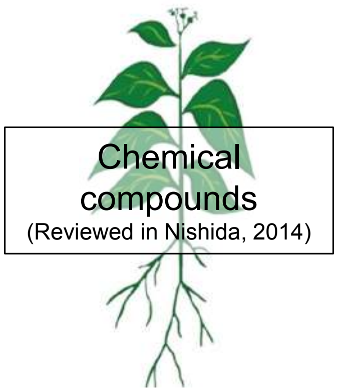
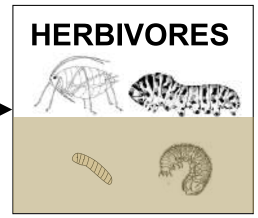
General context



General context

Defenses
(Reviewed in Chen, 2008)



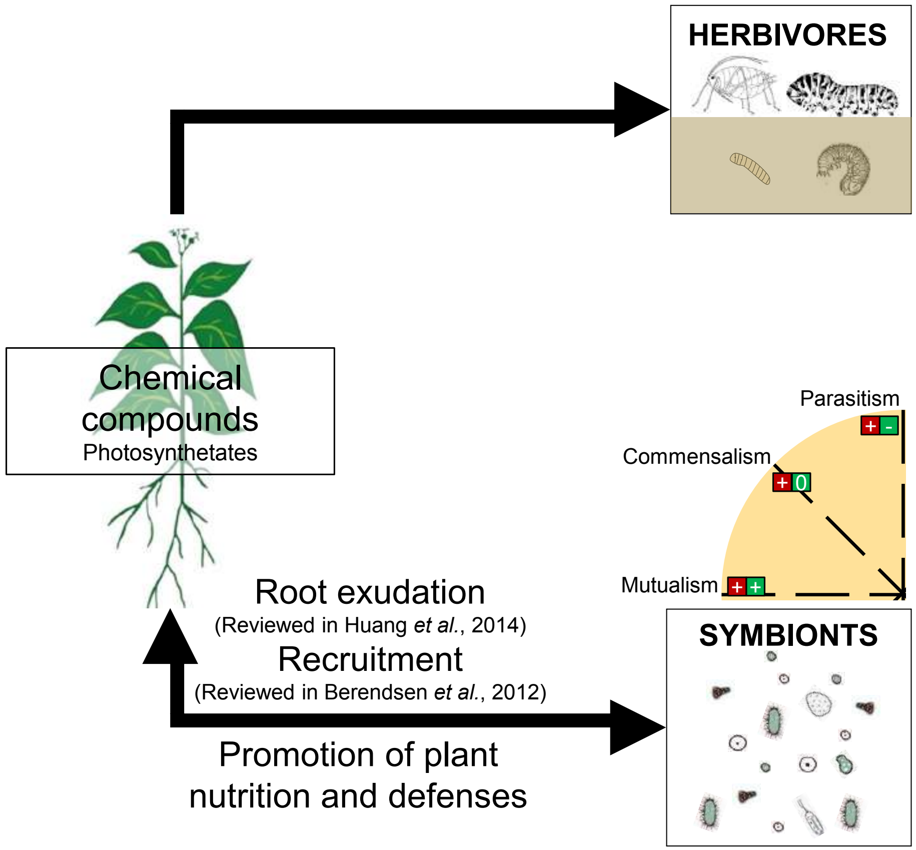
Chemical compounds
(Reviewed in Nishida, 2014)

Secondary metabolites
(Reviewed in Fürstenberg-Hägg *et al.*, 2013)

Alcaloids, phenolics, glucosinolates

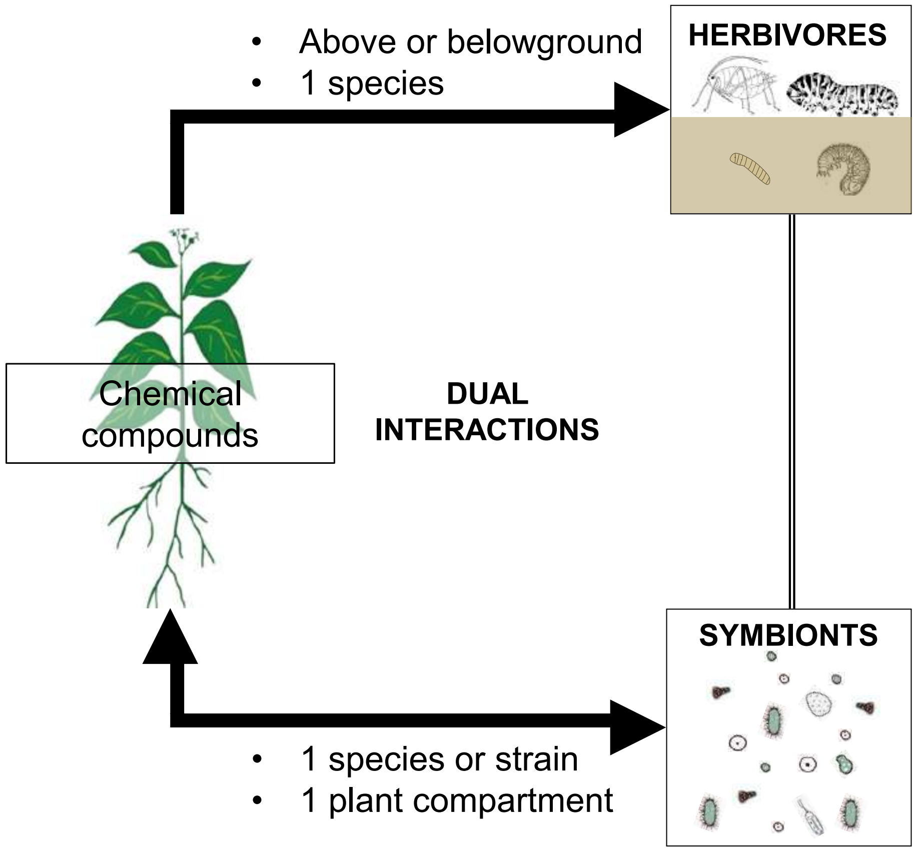
Plant-insect interactions induce defense production: physical or chemical defenses (food supply, nutrient value, damages)

General context



- **Plants recruit microorganisms using their chemistry**
- **Mutualist microorganisms promote plant growth and health**

General context



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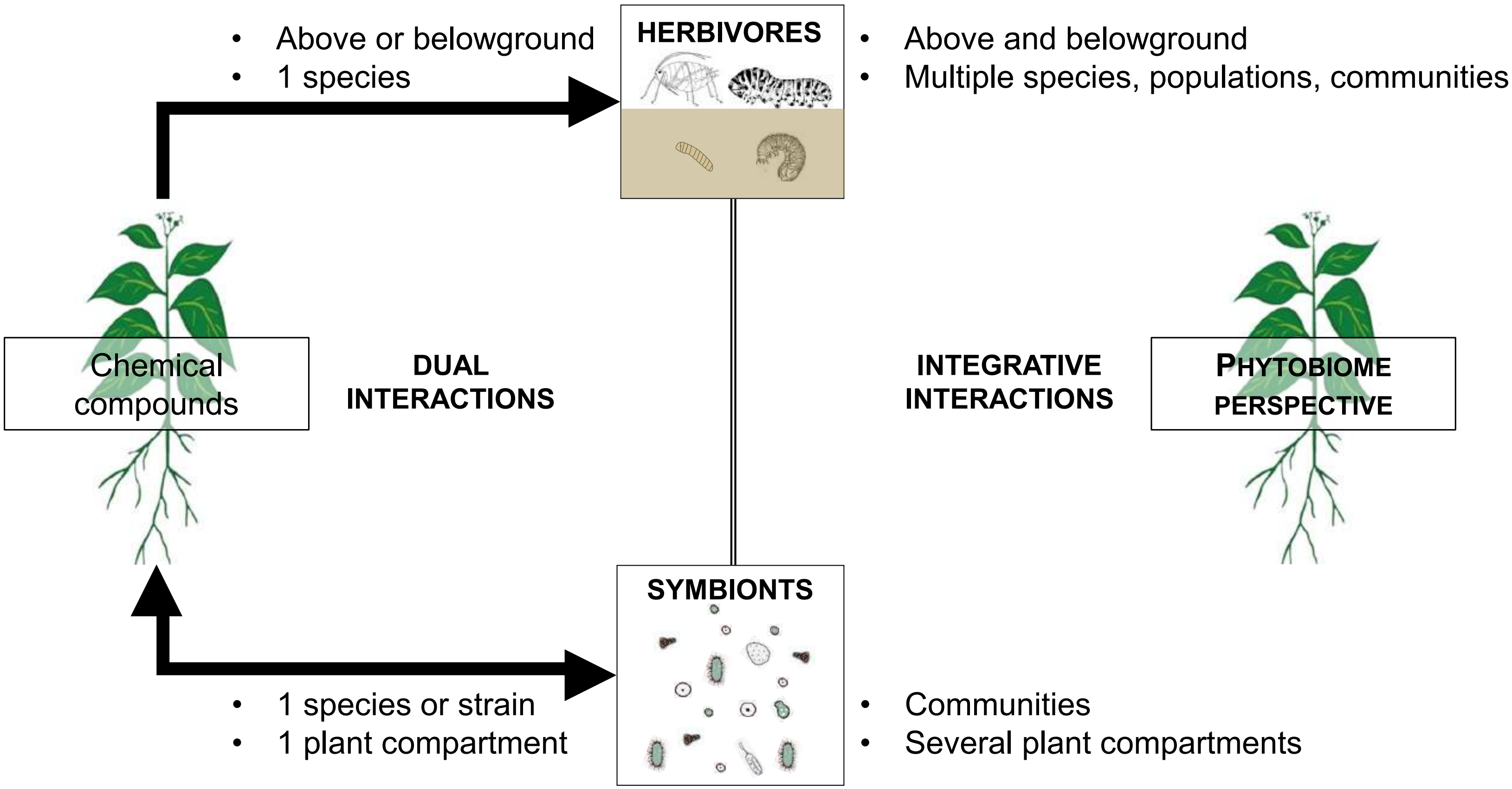
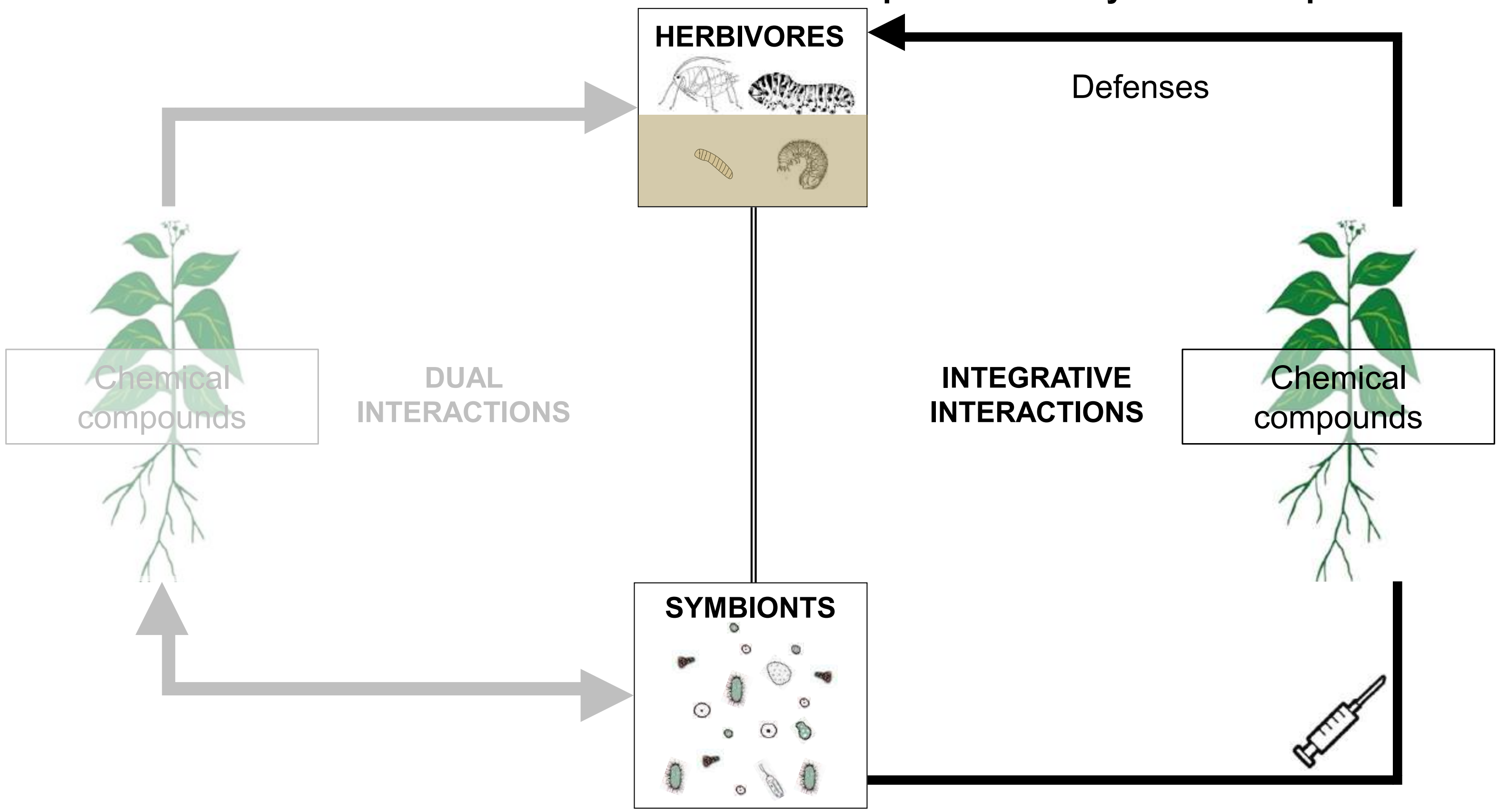


Through manipulation, soil microbiota can modify plant chemistry and insect performance (Hol *et al.*, 2010)



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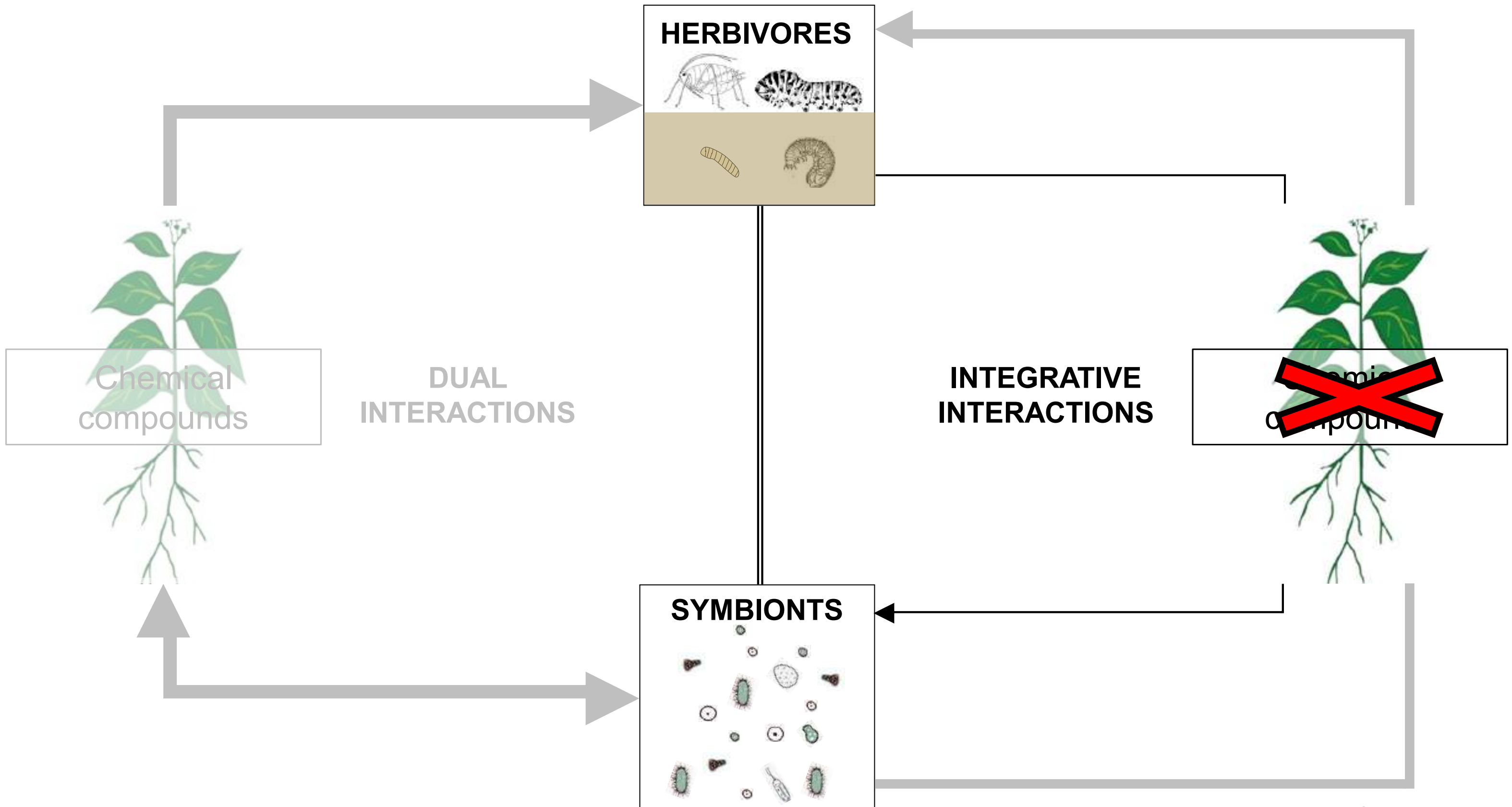
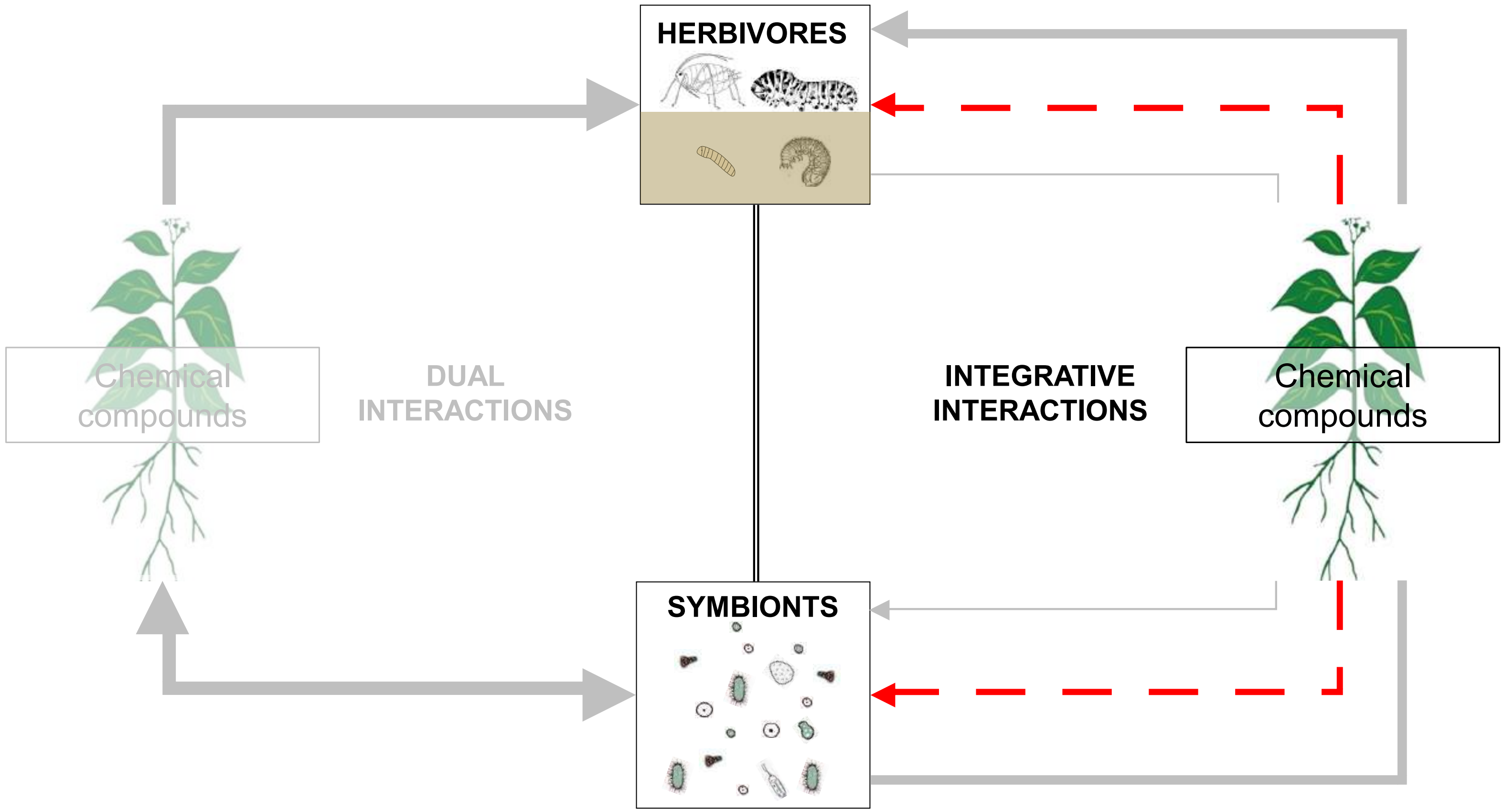


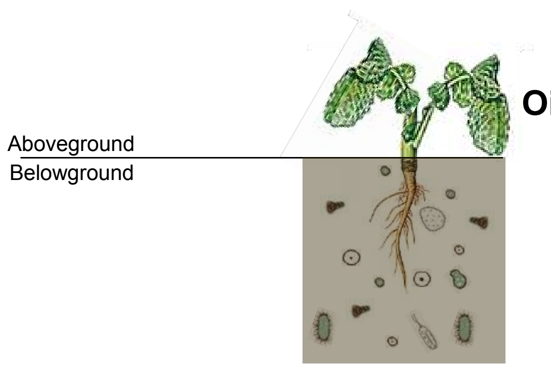
Aboveground herbivory modified the rhizosphere microbial communities (Kong *et al.*, 2016)

General context



The plant is a key biological hub, influenced by both above (herbivory) and belowground (soil symbionts) factors

Cabbage root fly
(*Delia radicum*)
Root herbivore as a larva

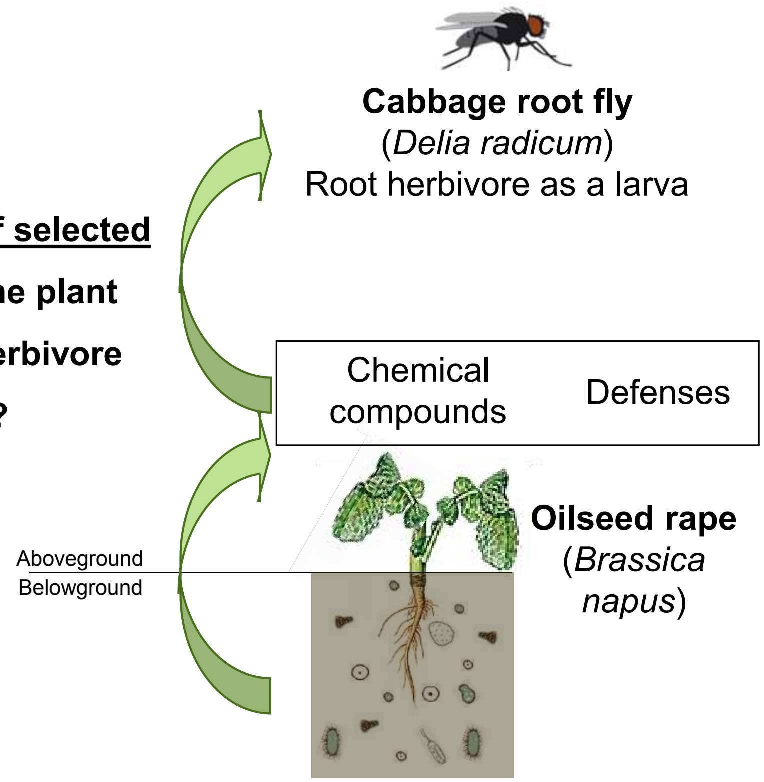


Oilseed rape
(*Brassica napus*)

Soil microbial communities

Studying the tripartite interaction between a root herbivore, a crop plant and soil microorganisms

What are the <u>effects of selected soil microbiota</u> on the plant chemistry and the herbivore development?



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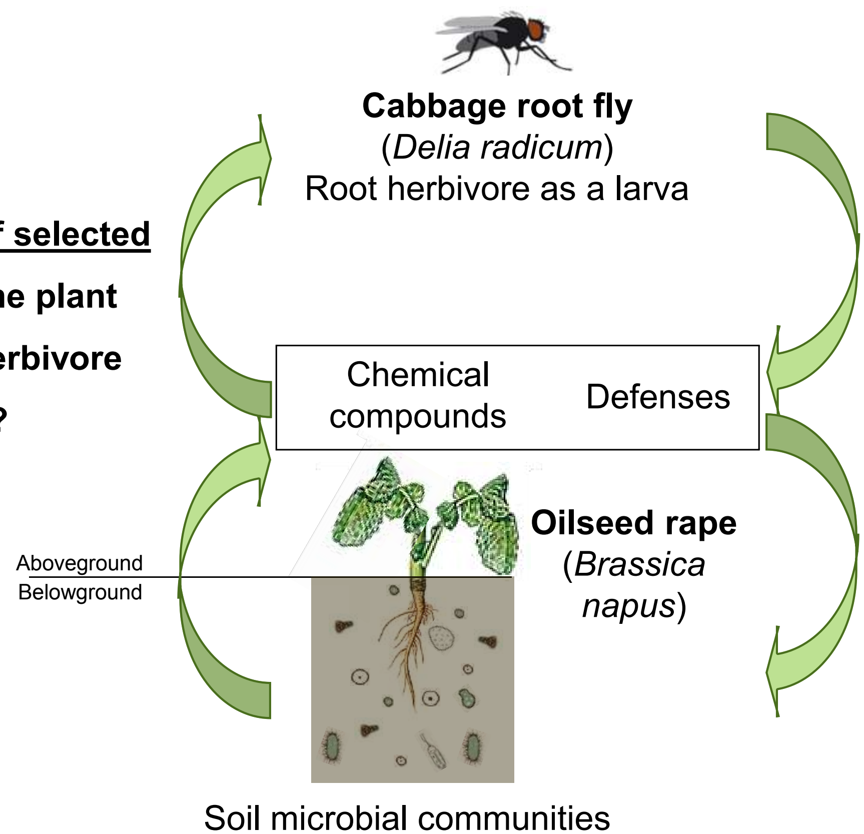

What are the effects of root herbivory on the plant chemistry and microbial communities?

Studying the tripartite interaction between a root herbivore, a crop plant and soil microorganisms

Hypotheses

- Soil microbial diversity influences the herbivore life history traits.
- Fly phenotype change can be explained by plant chemistry modulated by soil microbial diversity.

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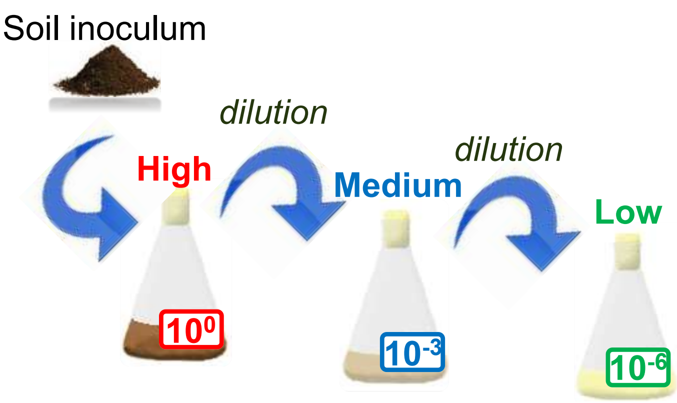
Materials and methods

➔ Experimental approach to manipulate soil microbiota

- Soil inoculum resuspended in water
- Series of dilutions: 3 dilutions selected



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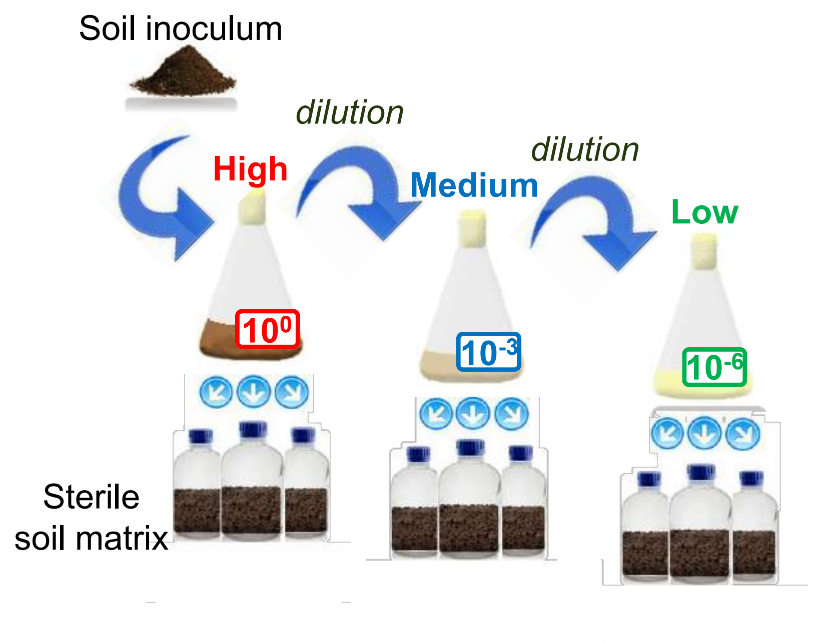
- Inoculation in the same soil matrix sterilized by gamma radiation



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Materials and methods

➔ Experimental approach to manipulate soil microbiota

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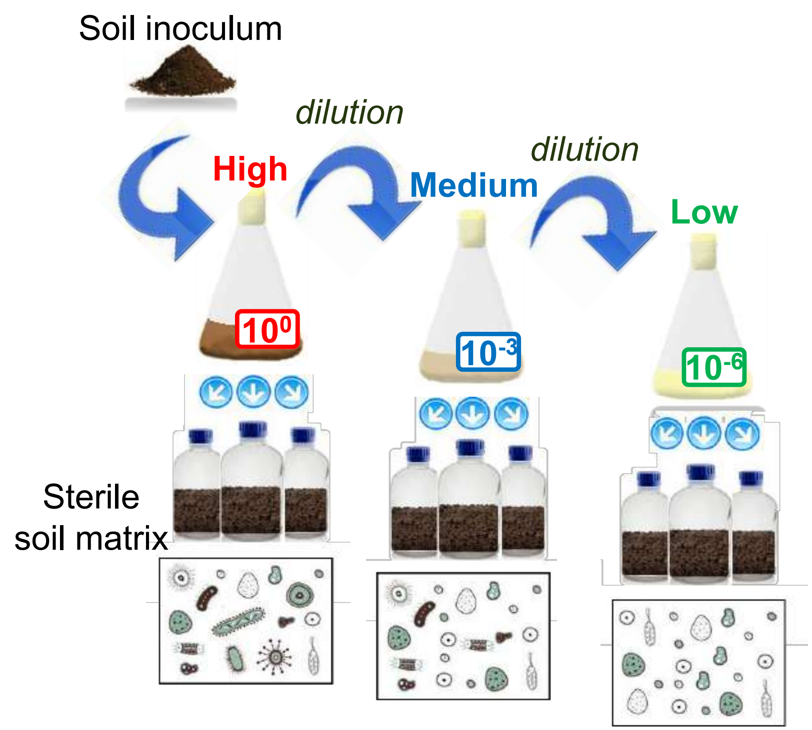
- Series of dilutions: 3 dilutions selected
- Inoculation in the same soil matrix sterilized by gamma radiation
- Incubation for 2 months to reach similar microbial density



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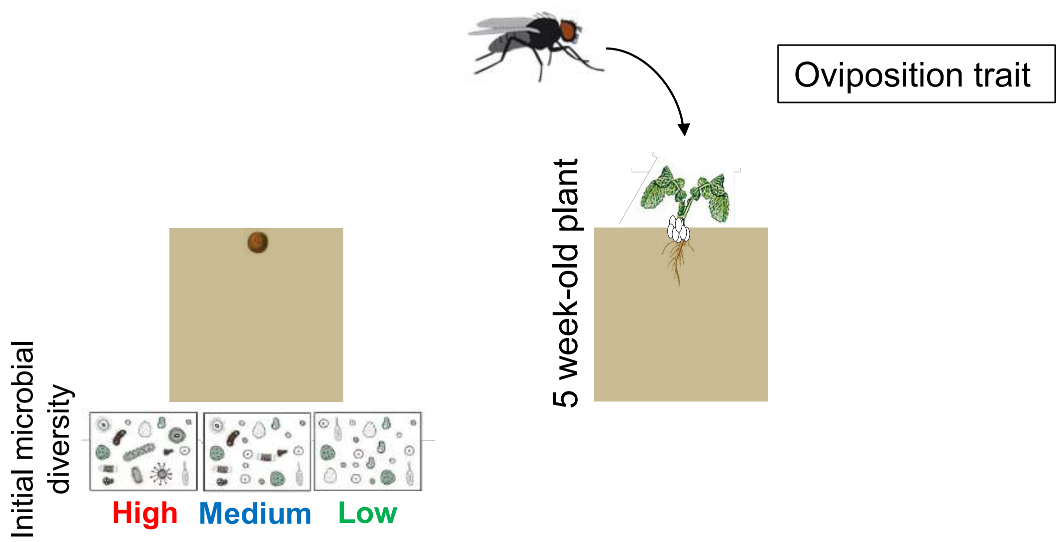

General context | Biological models and objectives | Effects of initial soil microbial diversity

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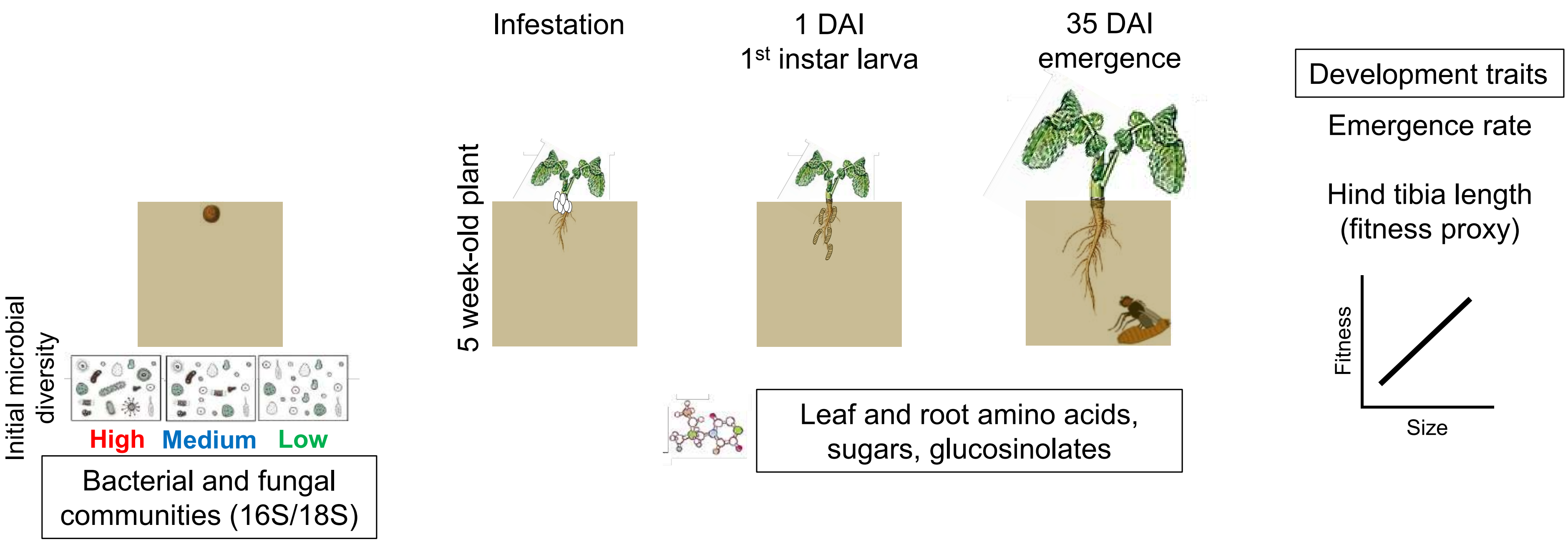

Analysis of initial soil microbial diversity – diversity indices

- Bacterial alpha-diversity (richness and diversity): High > Medium > Low (P = 0.001)

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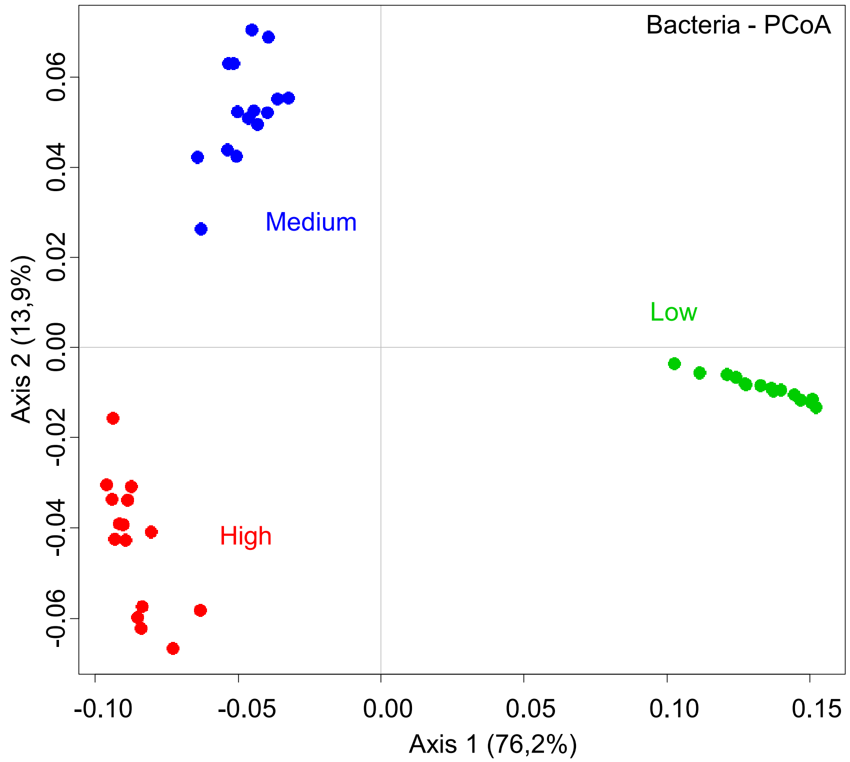

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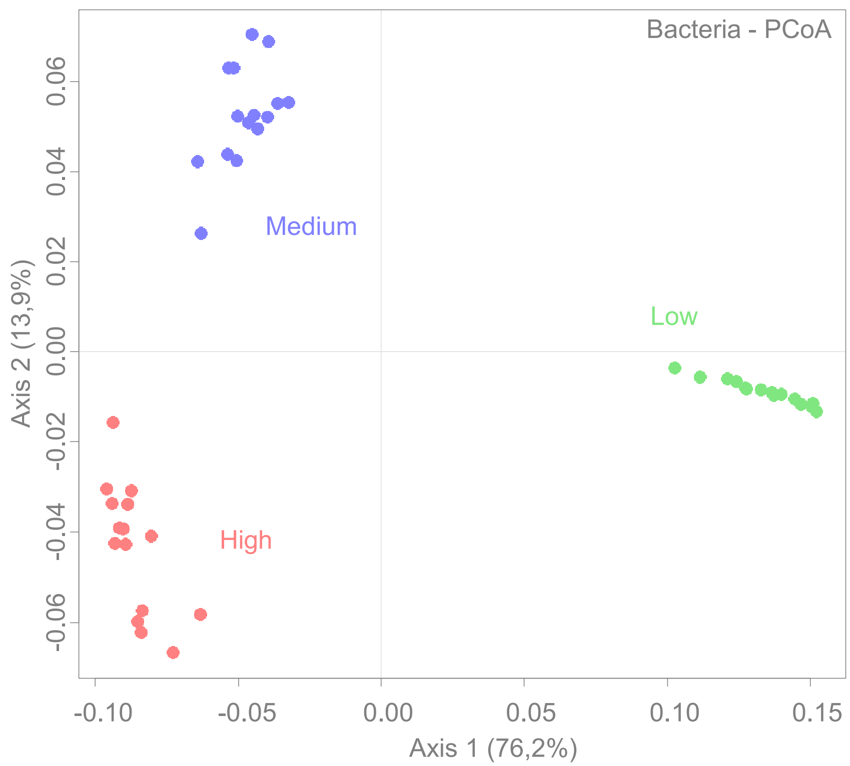
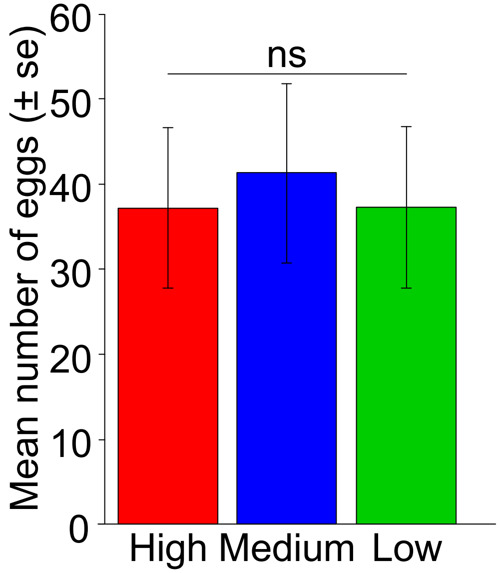


Similar results for fungi

Validation of 3 microbial diversities obtained through the dilution to extinction method in the same soil matrix

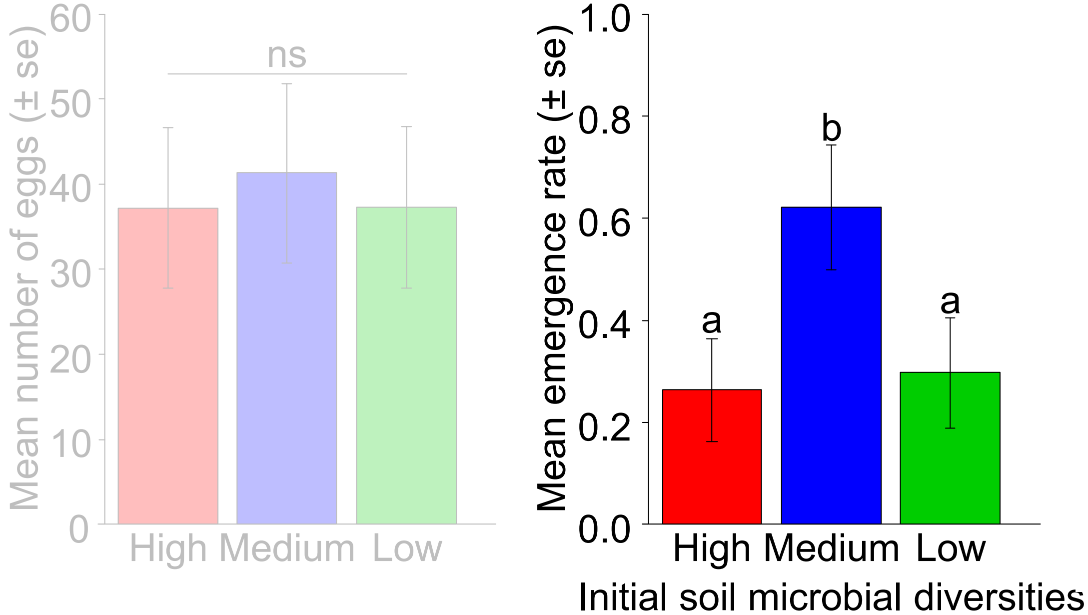
Analysis of *D. radicum* life history traits



Initial soil microbial diversities

- Oviposition: no significant differences for the egg number

Analysis of *D. radicum* life history traits



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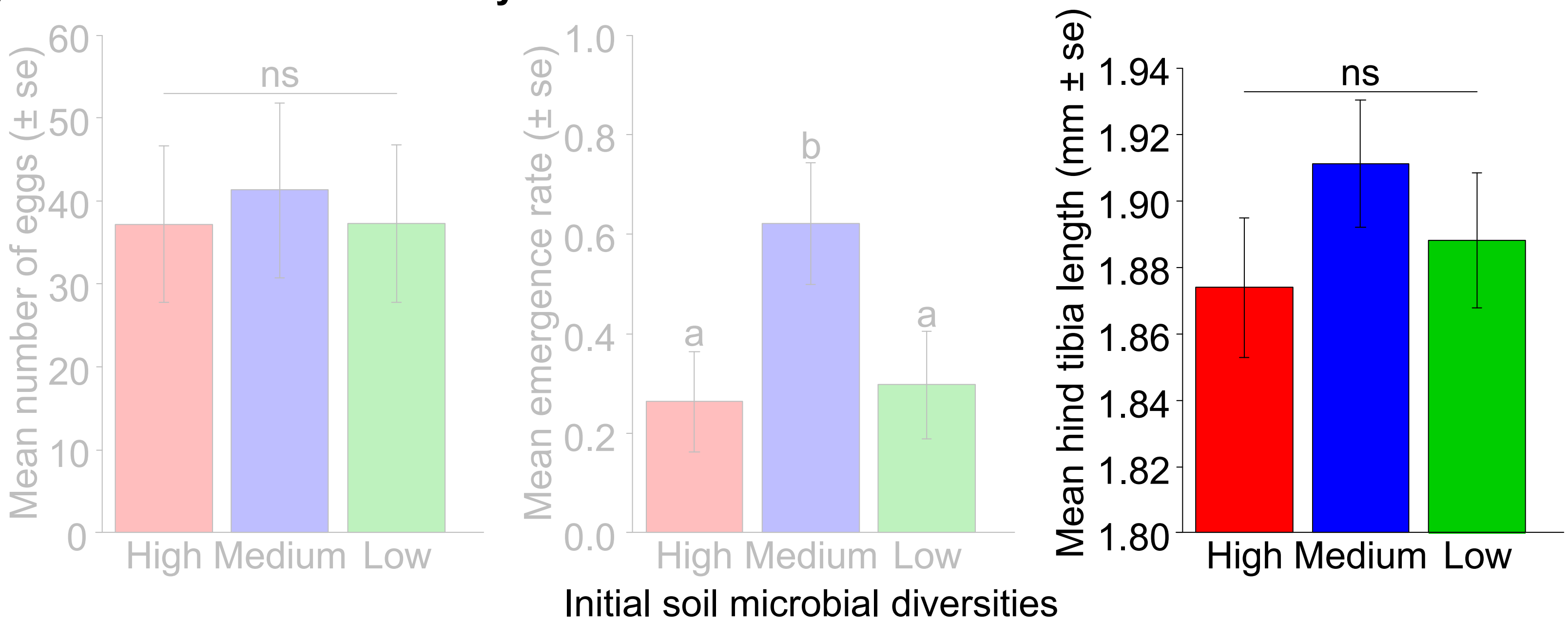
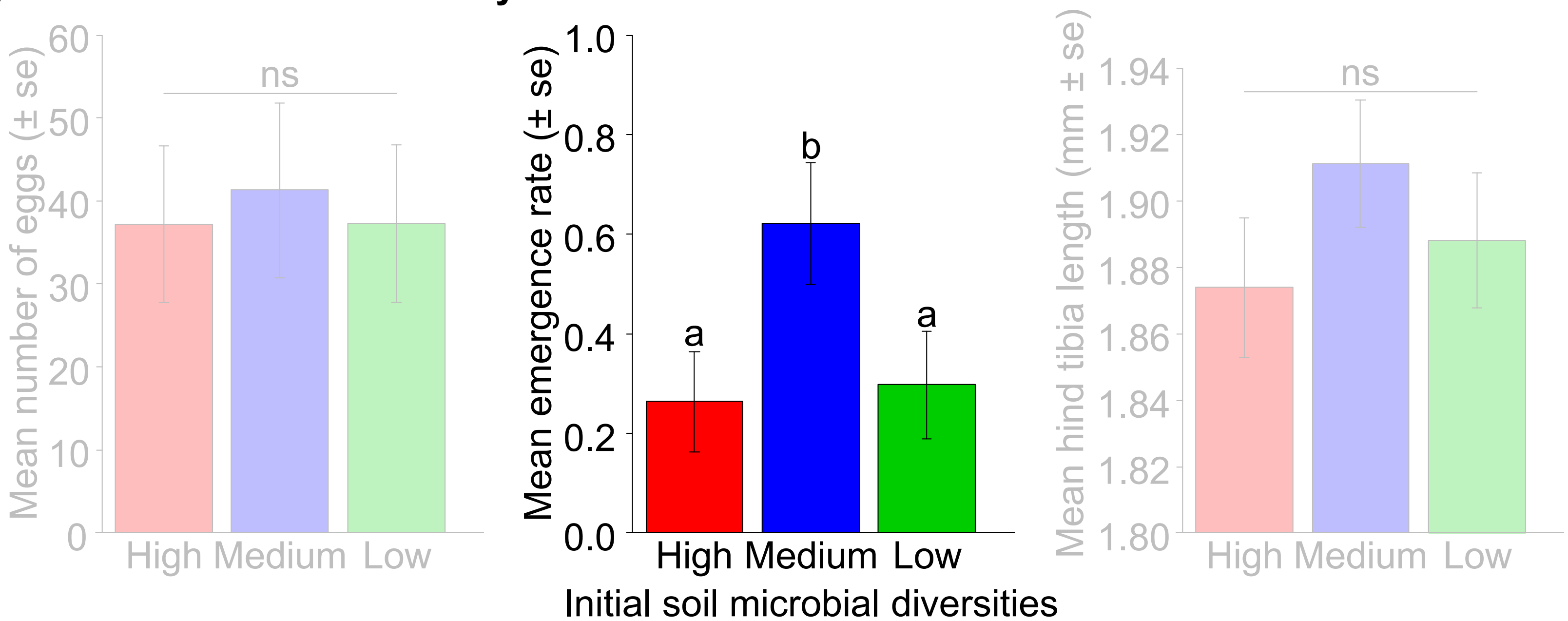


- Oviposition: no significant differences for the egg number
- **Emergence rate: medium > high = low**
- Fitness: similar tibia length between soil microbial diversity

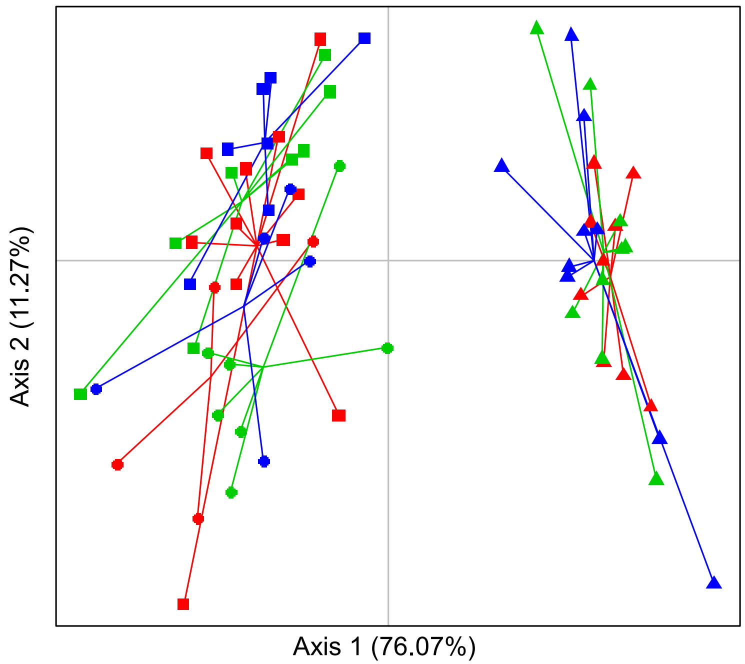
Analysis of *D. radicum* life history traits



Does medium diversity increase larval survival? Or, on the contrary, do the other 2 modalities decrease it?

Plant chemistry can influence insect phenotype (van Leur *et al.*, 2008): investigation of amino acids, sugars and glucosinolates in the leaves and roots

Analysis of *B. napus* root metabolites – RDA

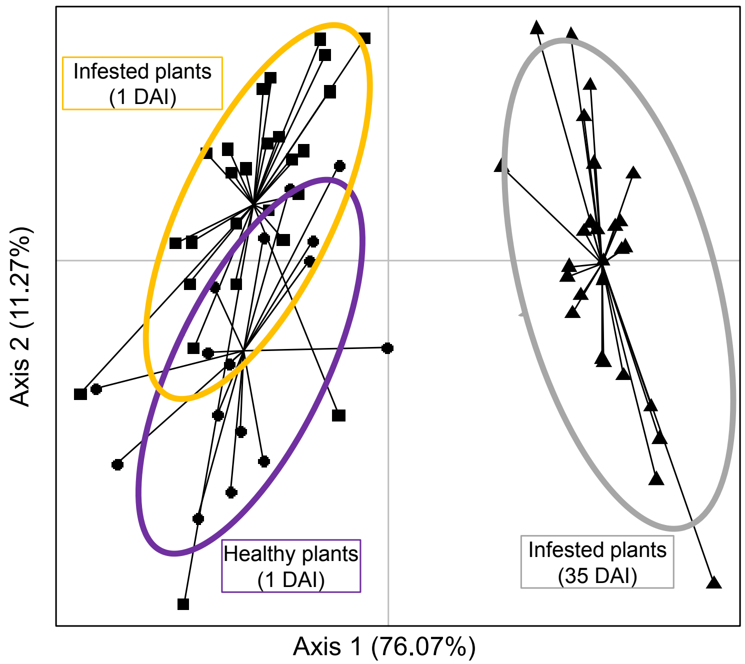


Plant treatment and initial soil microbial diversity

- ● Healthy plants (1 DAI)
- ■ Infested plants (1 DAI)
- ▲ Infested plants (35 DAI)
- High
- Medium
- Low

No effect of initial soil microbial diversity on root metabolites analyzed (**P = 0.285**)

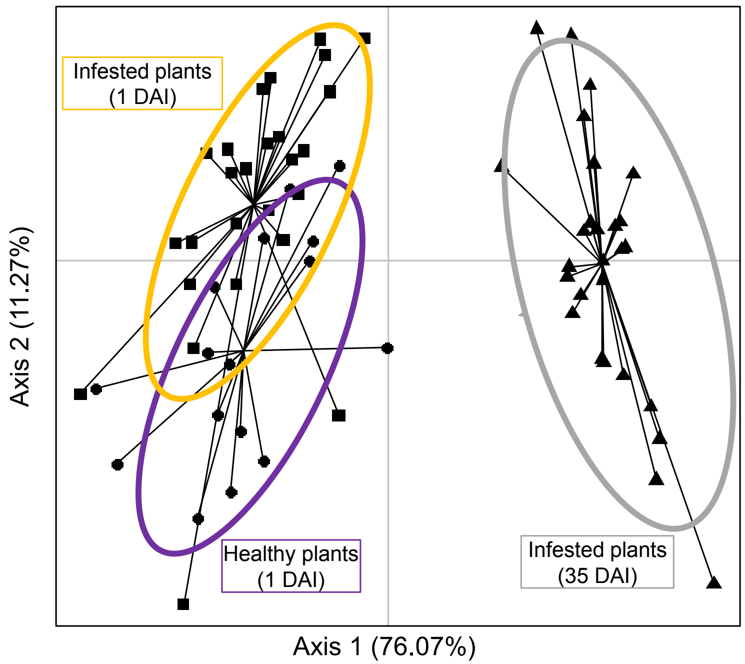
Analysis of *B. napus* root metabolites – RDA

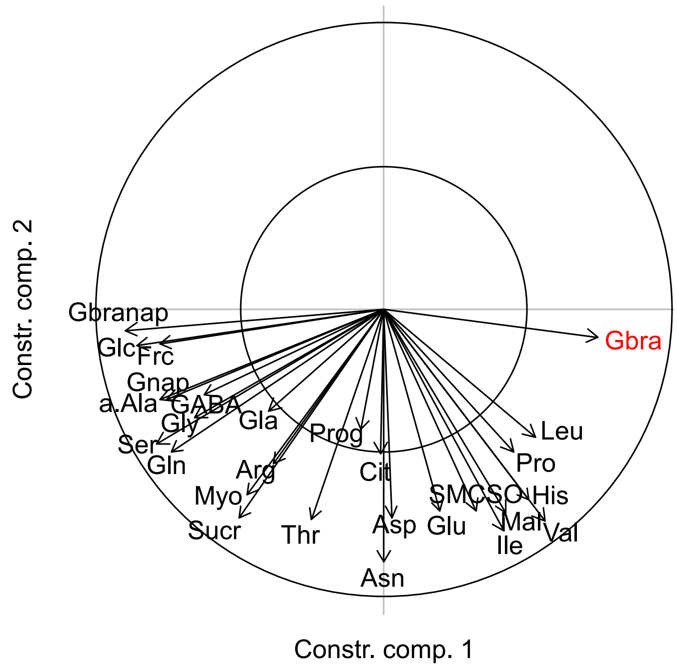


But 3 different profiles according to the treatment (P = **0.001**)

Infestation effect >> initial soil microbial diversity effect

Analysis of *B. napus* root metabolites – RDA



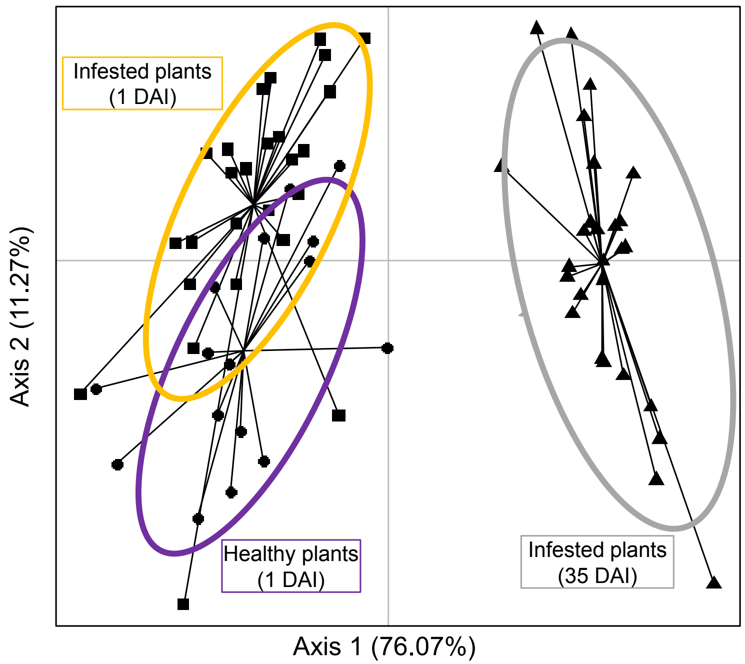


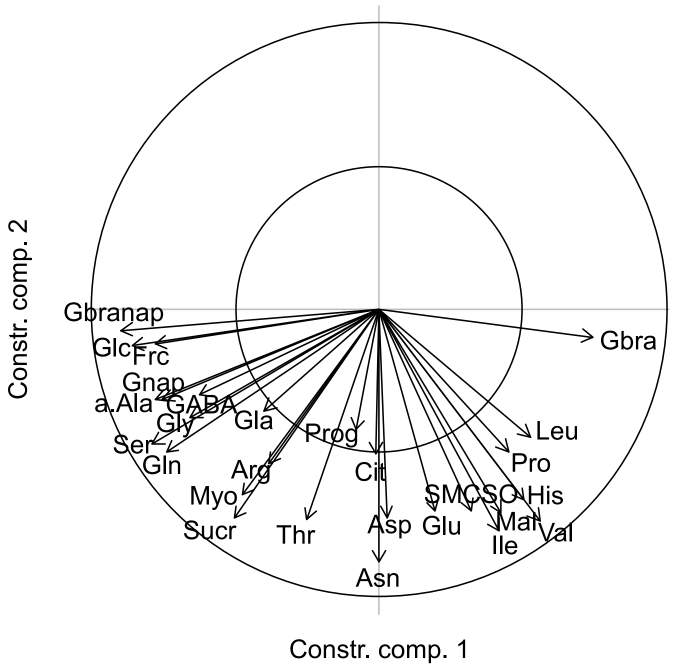
Infested plants:

decrease of most metabolites except for glucosinolates

(Hopkins *et al.*, 2009)

Analysis of *B. napus* root metabolites – RDA





Infested plants: decrease of most metabolites except for glucosinolates

(Hopkins *et al.*, 2009)

Infestation coupled to the time factor is a strong driver of root chemistry.

What is the impact of root herbivory on plant chemistry and microbial community dynamics?

Hypotheses

- Root herbivory modifies plant physiology
- As consequences, microbial communities are influenced

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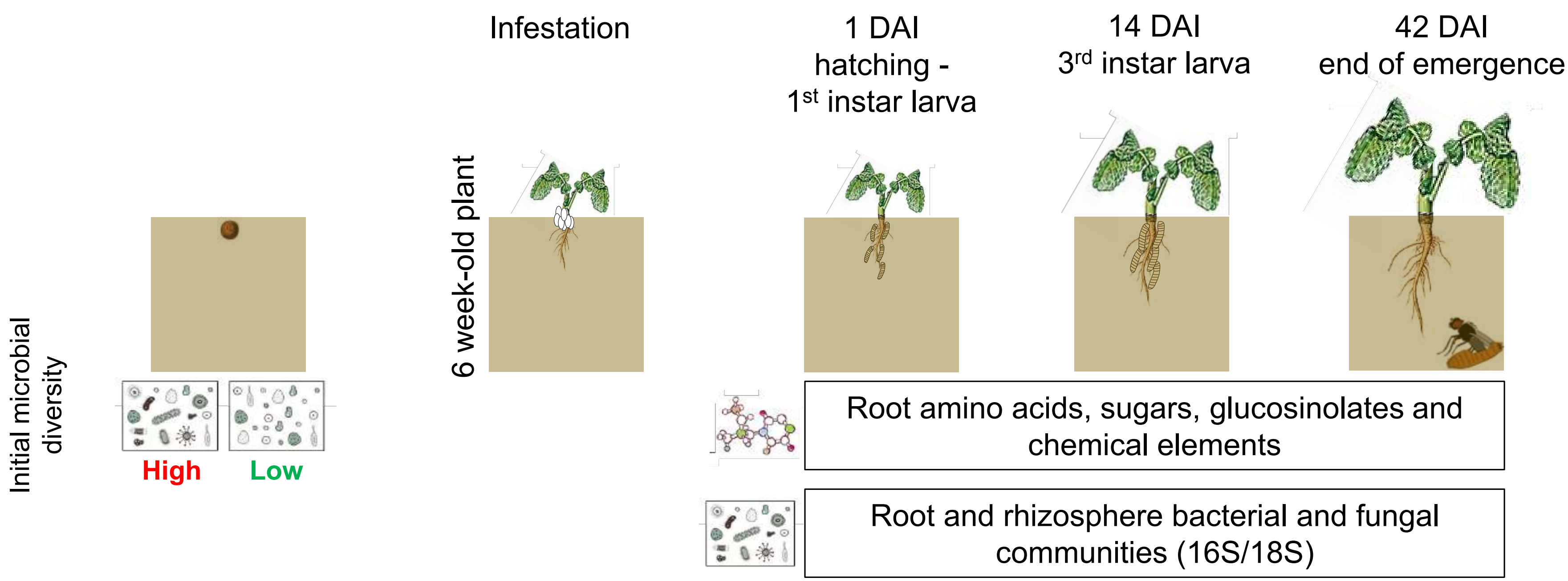
Materials and methods



General context | Biological models and objectives | Effects of initial soil microbial diversity | Effects of root herbivory

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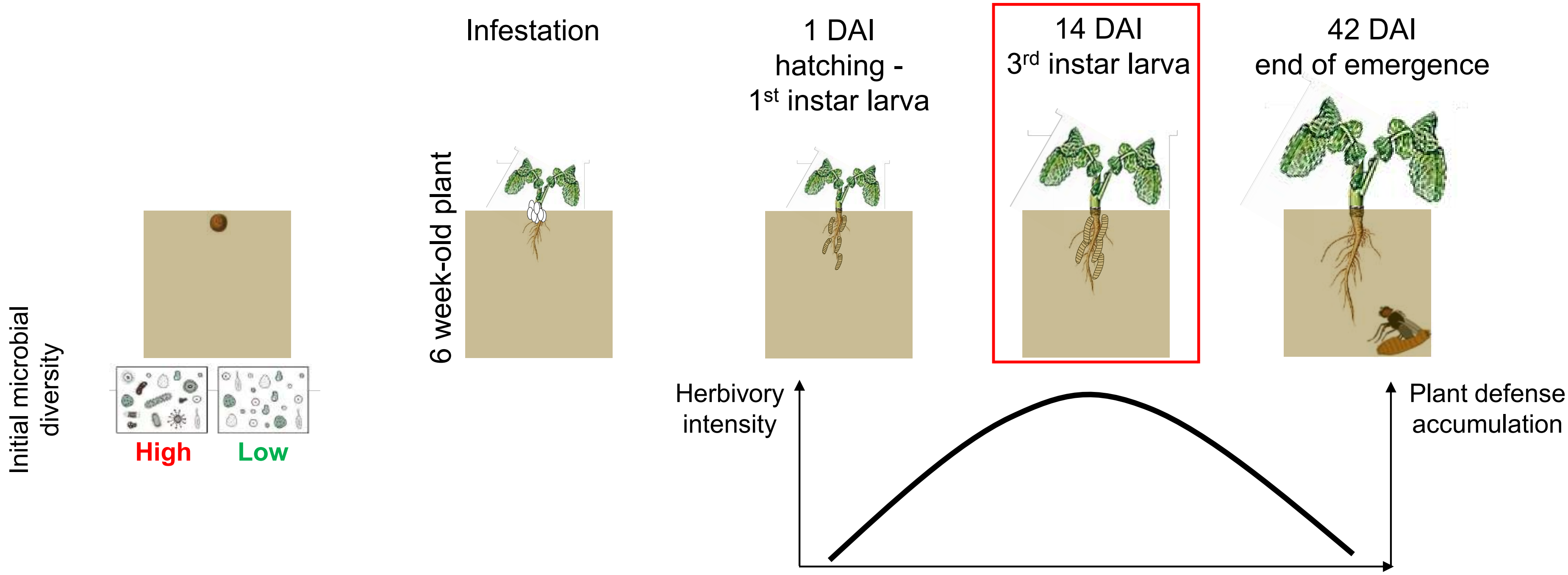
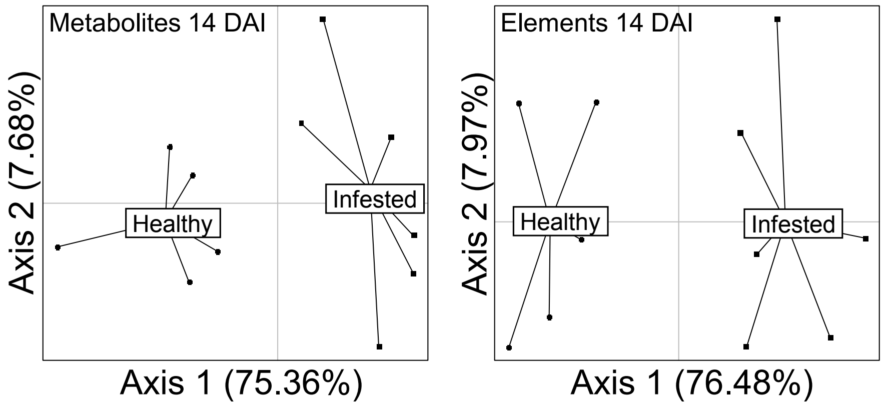
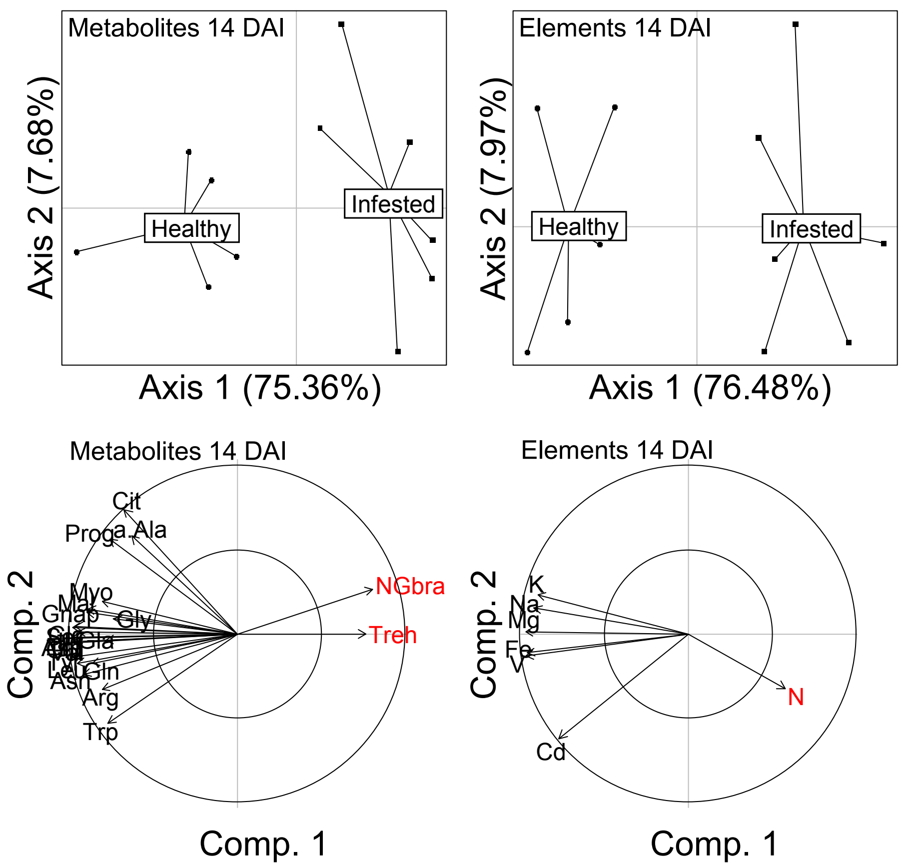


Results (DIABLO) – Root chemistry analysis



Herbivory influenced the root metabolomics and elemental profiles

Results (DIABLO) – Root chemistry analysis



Herbivory influenced the root metabolomics and elemental profiles

- Most compounds decreased

But: increase of

- Trehalose and neoglucobrassicin
- Nitrogen

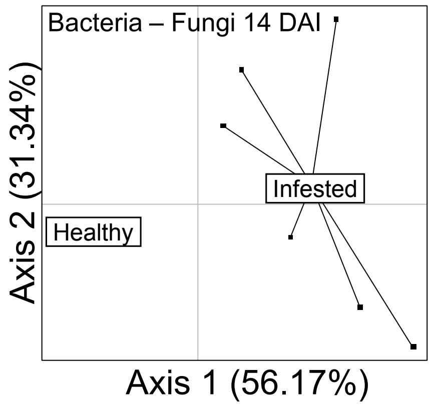
Results (DIABLO) – Microbial communities analysis

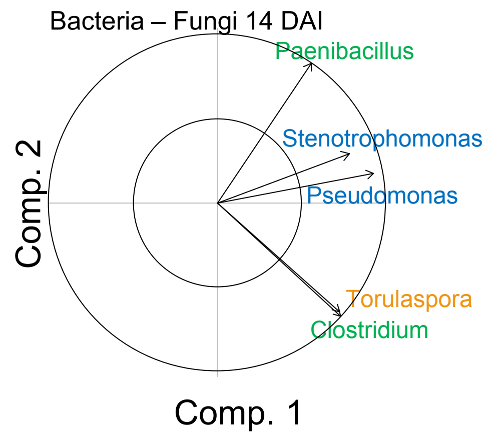
Herbivory influenced:

The root bacterial communities

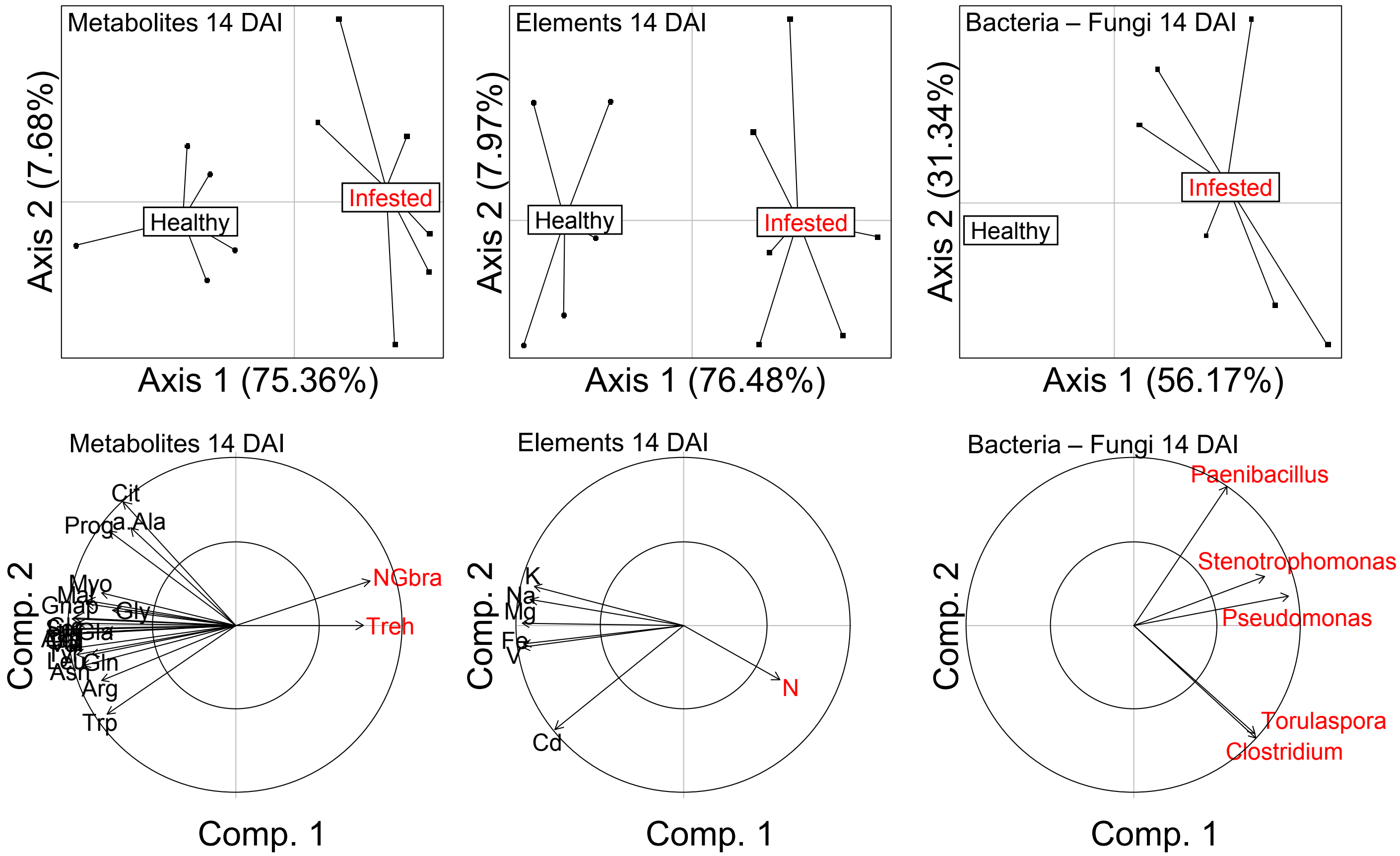
- Increase of *Pseudomonas* and *Stenotrophomonas* abundances (γ-proteobacteria)
- Increase of *Clostridium* and *Paenibacillus* abundances (Firmicutes)

But fungal communities were impacted to a lesser extent.



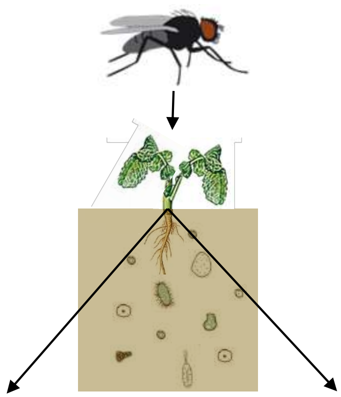


Results (DIABLO) – Relationship between root chemistry and microbial communities



At the peak of herbivory, chemical modifications can be associated to changes in microbial communities (Hervé *et al.*, 2018: Singh *et al.*, 2018)

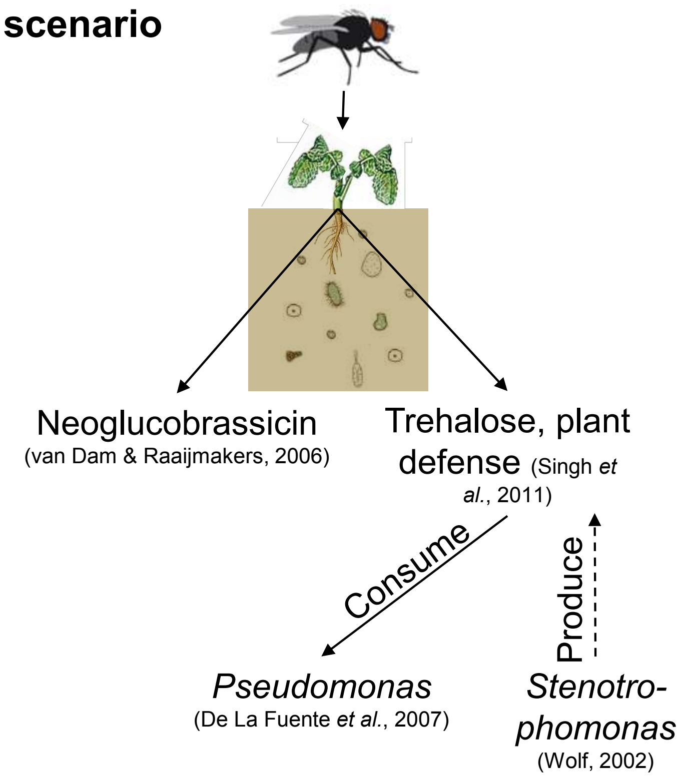
Potential scenario



Neoglucobrassicin
(van Dam & Raaijmakers, 2006)

Trehalose, plant defense (Singh *et al.*, 2011)

Potential scenario



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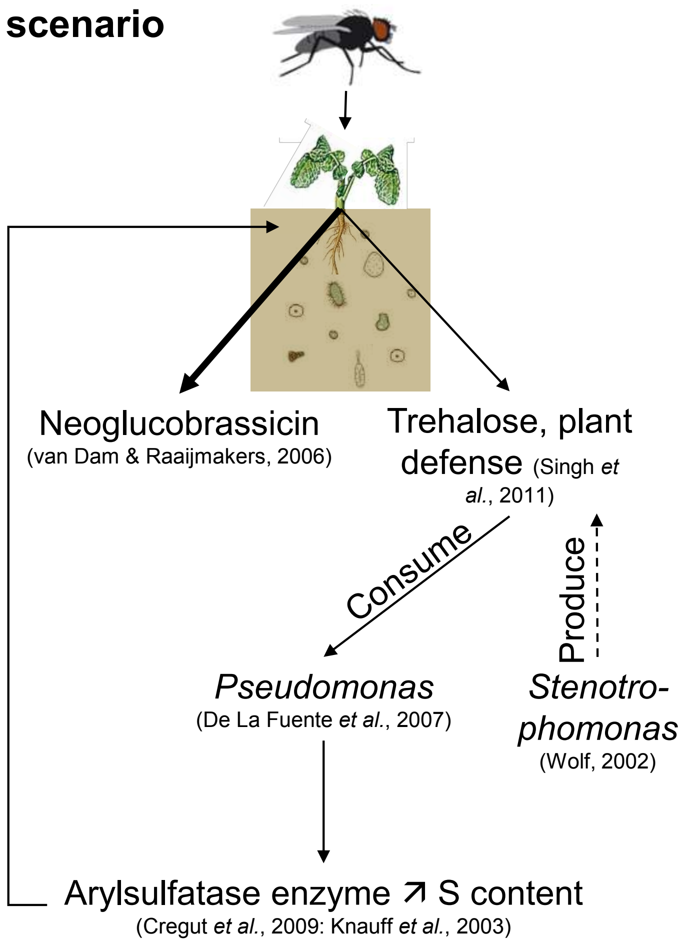
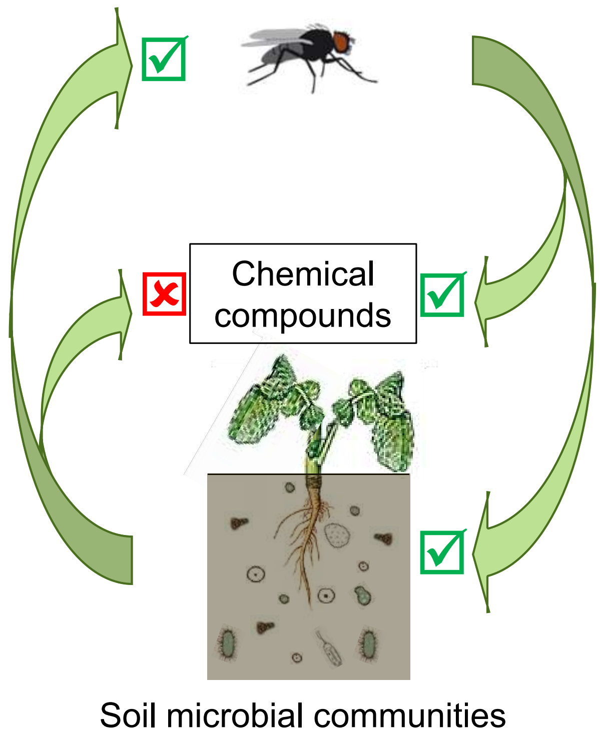


Against herbivory, plants produce defensive metabolites but also attract and recruit microorganisms with chemical compounds to maintain their defenses.

Take-home message



Effects of initial soil microbial diversity

- Modulation of the fly phenotype
- No link to chemical changes

Effects of root herbivory

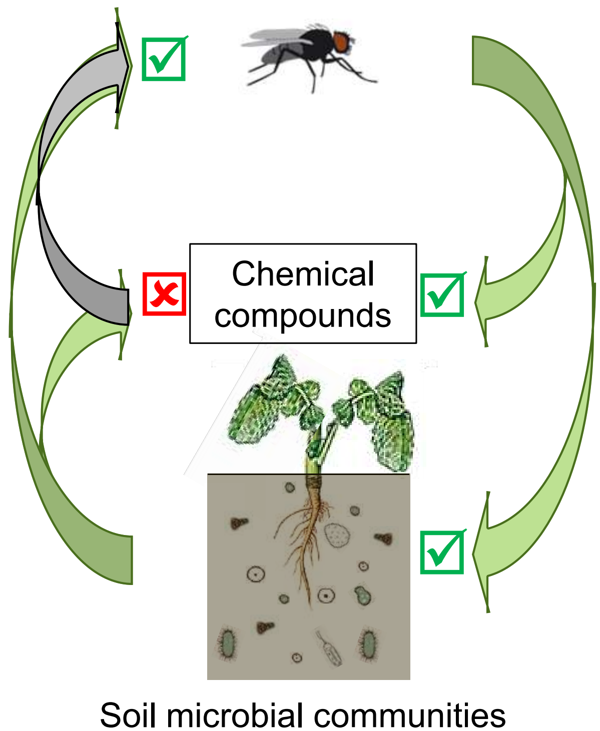
- Influence of root chemistry
- Modification of the plant microbial communities

Perspectives

➔ Determine the drivers responsible for the fly phenotype changes and microbial community modifications

Measure other plant defenses well-documented: chemical compounds, root physical defenses

(Reviewed in Chen, 2008)



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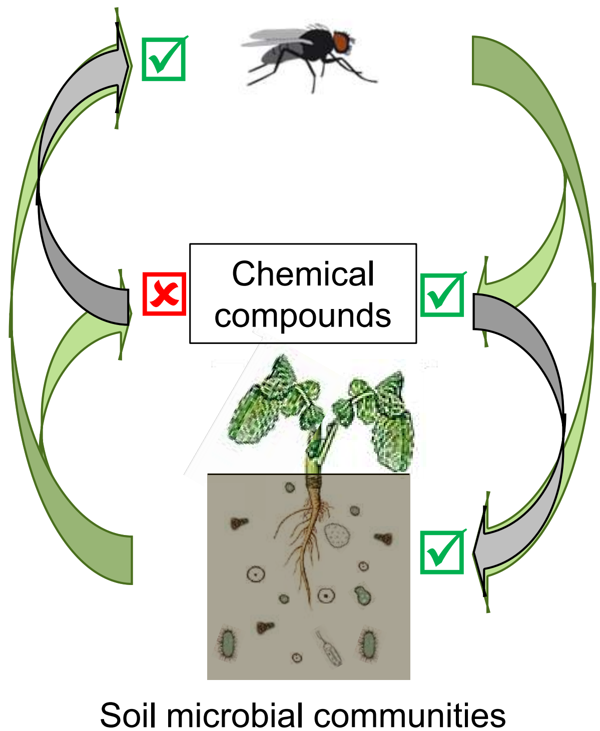

Differentiate plant chemical compounds from microbial ones

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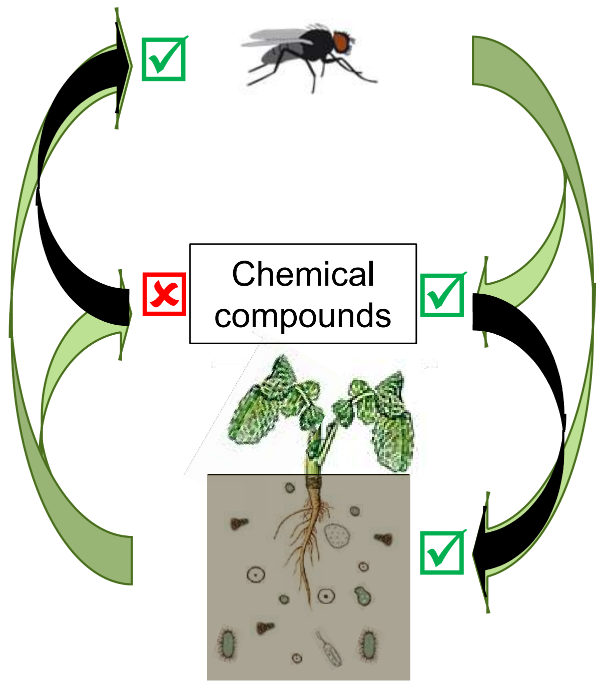

Differentiate plant chemical compounds from microbial ones

Identify functions and assess gene expression associated to each actor of this tripartite interaction

Acknowledgements

IGEPP Institut de Génétique, Environnement et Protection des Plantes

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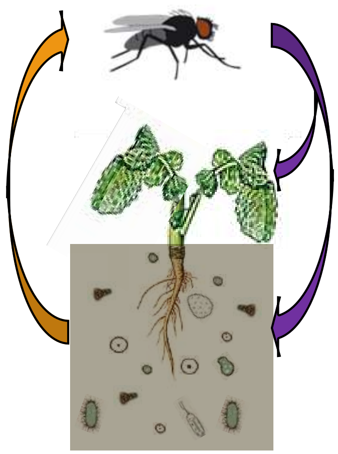
Région BRETAGNE

GDR GÉNOMIQUE ENVIRONNEMENTALE

Insect team



Lachaise*, Ourry* *et al.*, Insect Science (2017). DOI: 10.1111/1744-7917.12478

Ourry *et al.*, Frontiers in Ecology and Evolution (2018). DOI: 10.3389/fevo.2018.00091

Microbiota team

Chemical analysis platforms

bia Biopolymères Interactions Assemblages

PM

EVA

UNIVERSITÉ CAEN NORMANDIE

PLATIN

Sequencing platform

GenoScreen

INRA PhytoMic network

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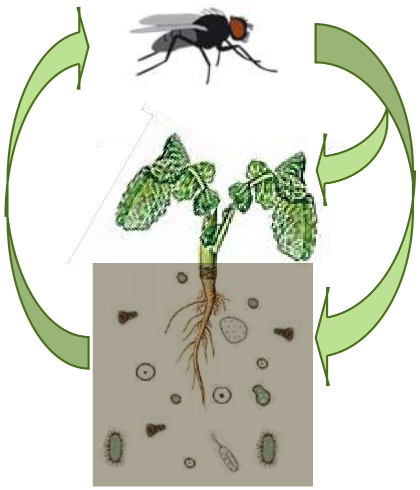

Poster P165

Looking for a postdoc starting in 2020

morgane.ourry@hotmail.fr