Study of Multitrophic Interactions and Bioinsecticide Efficacy under the Influence of Global Change in Beet Crops

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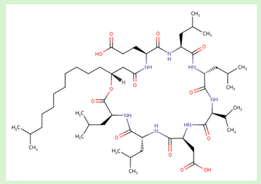
Introduction : Since the ban on neonicotinoids, its has become crucial to find alternative **natural pesticides** and to favour the use of **crop auxiliaries** as part of biological control, while assessing the efficacy of these alternatives in the context of **global change**. Variations in climatic factors may indeed affect **biotic interactions** directly, as well as through a modulation of pesticides efficiency *(Delcour et al., 2015)*. The Interreg "**Trans-Pest**" programme (Biocontrol 4.0) focuses on understanding the effects of environmental variations on current solutions and improving their **resilience** and application under changing climatic condtions. Within the framework of this programme, the first aim of this thesis is to **evaluate the efficacy of biopesticides on pests and the unintended effects on natural enemies.** The tritrophic system studied includes : the sugar beet *Beta vulgaris*, the black bean aphid *Aphis fabae*, vector of the beet yellows viruses, and one of its parasitoids *Aphidius colemani*. Secondly, **the effects of biopesticides on the trophic system will be studied in a context of climatic variations.**

1 Study the bottom-up effect of different biopesticides on the tritrophic plant - pest - parasitoid interaction

Assess intented and unintended effects of :

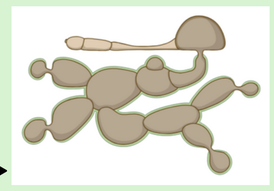


Surfactins

Extracted from the *Bacillus* genus, surfactins have been identified as having **insecticidal** properties against several insect orders *(Denoirjean et al., 2021)*.

Essential oils (EOs)

EOs provide a wide range of bioactive compounds manipulating the **olfactory** and **gustatory** environment of insects *(Denoirjean et al., 2022)*.

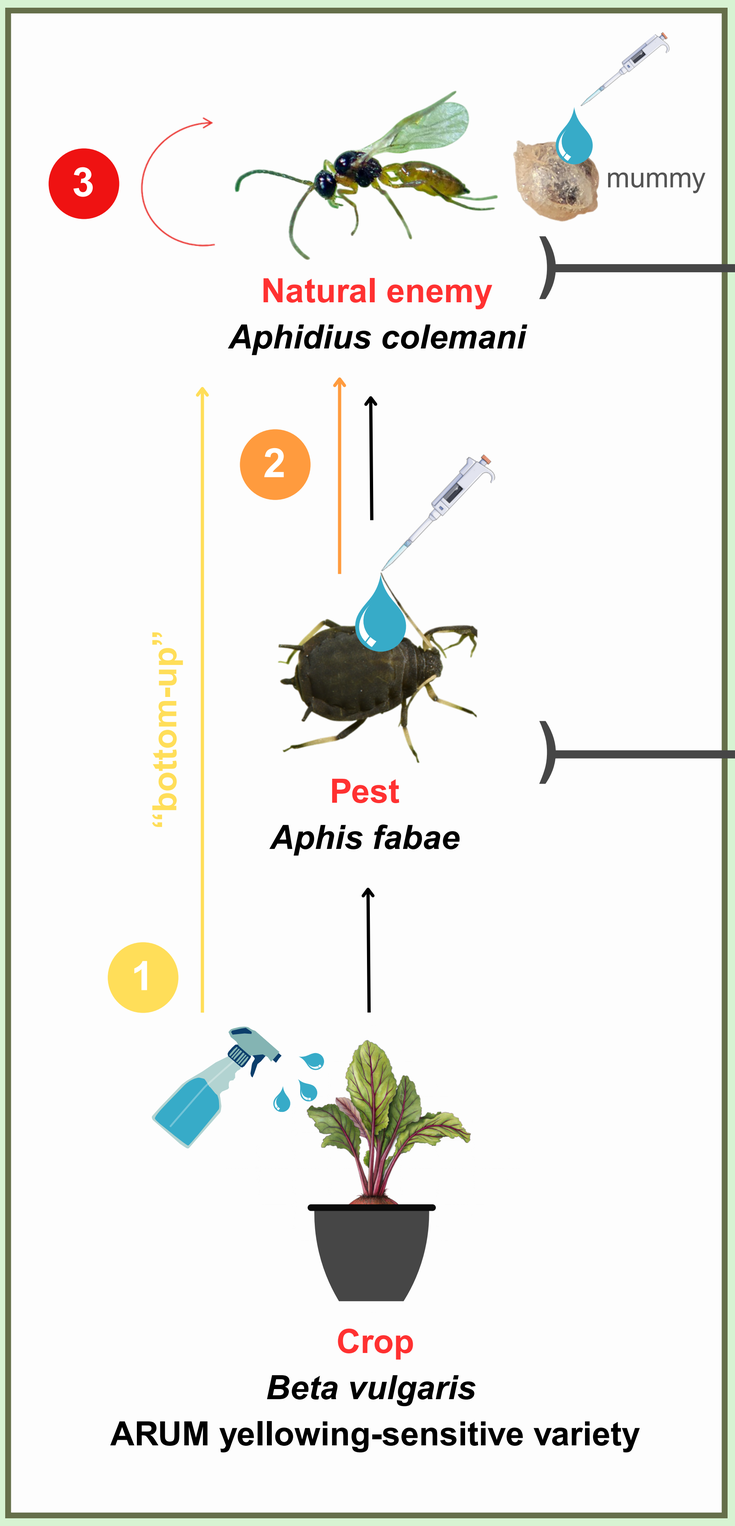


Entomopathogenic fungi (EF)

EF **penetrate the insect cuticle** and develop in their tissues, leading to their death. It has been shown that **parasitoids can be combined with EF** to increase the level of aphid control *(Mohammed & Hatcher, 2017)*.

At field concentrations :

1. Treatment of host plant : **bottom up effect on parasitoid**
2. Treatment of aphid : **effect on parasitoid**
3. **Treatment of parasitoid**

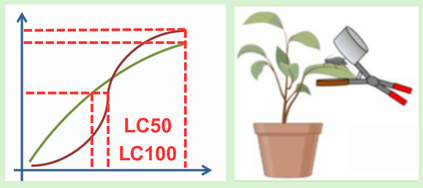


Thanks to :

- **Physiological approach :**

Survival, development time, emergence rate, sex ratio, mass, tibial length, egg load

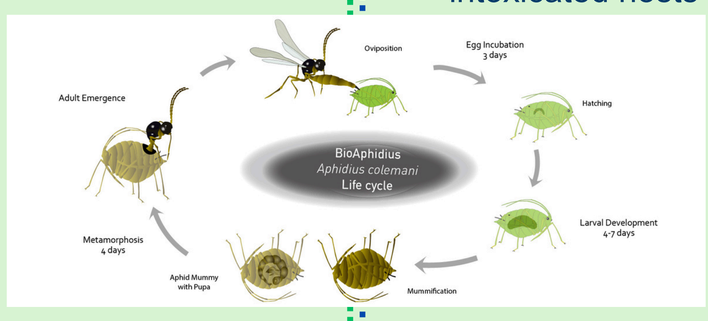
Survival, reproduction, size, mass



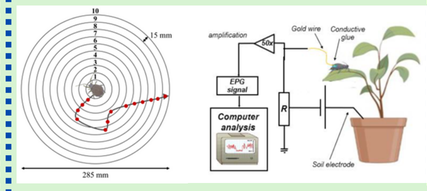
Ecotoxicological tests
Clip cage studies

- **Behavioral approach :**

Oviposition, Discrimination between intoxicated and non-intoxicated hosts



Locomotor activity, **Feeding** behavior



Dispersion, velocity
Electropenetrography (**EPG**)

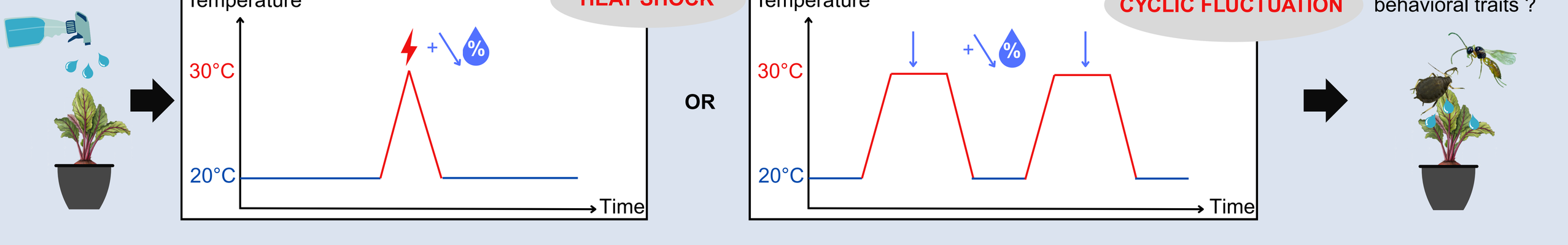
Parameters affecting **aphid colonization and viruses transmission** + **quality as host** for parasitoids

Parameters affecting **parasitoid biological efficiency**

2 Shifts in climate parameters : what impact on trophic interactions subjected to biopesticides?

In a **climate change scenario** (warming, water stress), the efficacy of biopesticides can be **reduced** by a **quicker degradation**, an alteration of their **persistence** and **bioavailability**, an induction of **conditional resistance** in targets, or by a **higher detoxification** in plant hosts. On the contrary, their efficacy may also be **amplified** through a decrease in target insects and host plant **performance** due to abiotic stress *(Matzrafi, 2019)*. Any type of alteration in the effectiveness of biopesticides can lead to **disruption of biotic interactions** in the tritrophic chain.

Beet treated with biopesticide is submitted to elevated temperature and/or water stress :



References :
Delcour *et al*., 2015. Food Research International, 68, 7–15.
Denoirjean *et al*., 2021. Pest Management Science. 78.
Denoirjean *et al*., 2022. EntomologiaExperimentalis et Applicata. 170.
Matzrafi, 2019. Pest Management Science, 75, 9-13.
Mohammed & Hatcher, 2016. Biocontrol Science and Technology, 26(10), 1379–1400.