Unraveling the Dynamics of Plant Growth, Immunity, and Pathogen Propagation in Apple Plants

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Context and Objectives

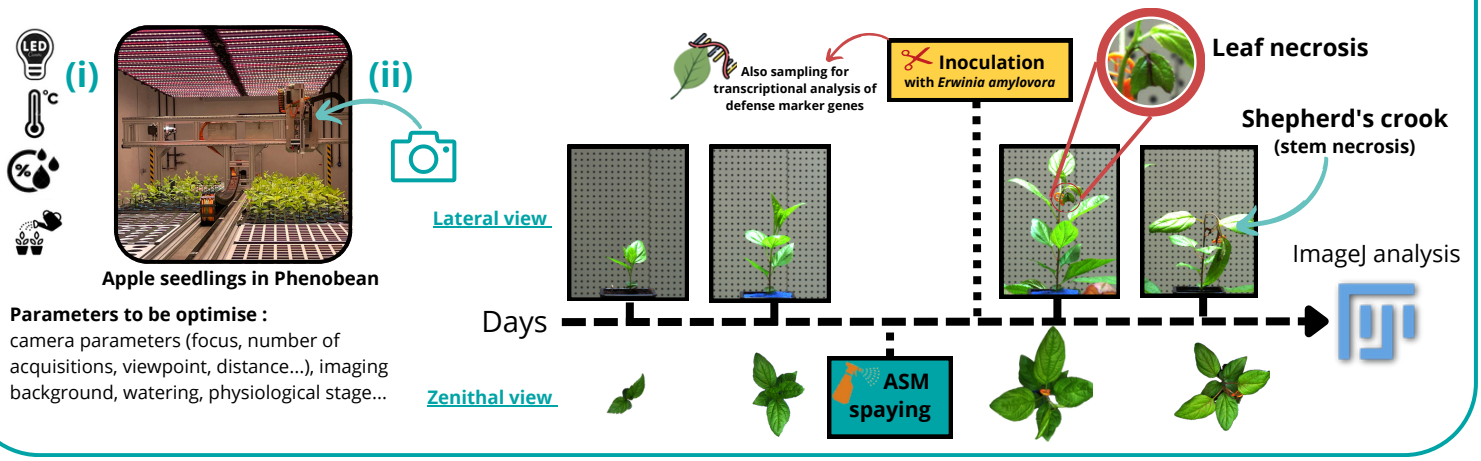
According to the "growth-defense tradeoff", plants must balance their resources between development and protection against pests (Huot et al., 2014). Supporting this theory at the molecular level, several hormones have an opposite role in growth and immunity, as shown in the model plant *Arabidopsis thaliana*.

In crops, exogenous applications of hormone analogs may boost immunity and thus be used as Plant Resistance Inducers (PRIs), reducing pesticide usage in orchards. For instance, acibenzolar-S-methyl (ASM) is a functional analog of salicylic acid (SA), the major hormone of plant immunity (Marolleau et al., 2017). In apple, ASM induces the transcription of defense marker genes (Warneys et al., 2018) and protection against *Erwinia amylovora* (*Ea*), the bacterium responsible for fire blight (Brisset et al., 2000). However, it is unknown whether defense induction is associated with temporary inhibition of growth. Here, using a state-of-the-art phenotyping platform, **we explore to what extent growth and immunity are (un)coupled by hormone-like products in apple plants**.

1 Temporal monitoring of seedling growth and pathogen propagation

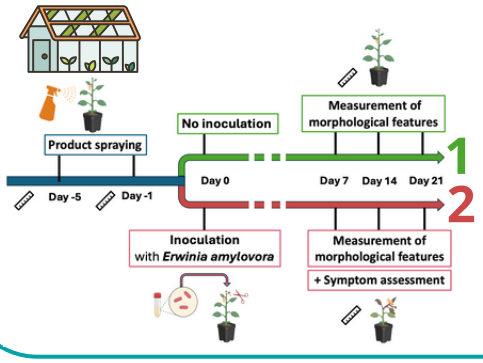
Our approach involves the utilization of the Phenobean robot, which **(i) enables the cultivation of apple seedlings under finely controlled environmental conditions** and **(ii) facilitates high-throughput phenotypic analyses using an RGB imaging system**.

By capturing daily images of the plants from various angles (lateral and zenithal views), we **can track the effects of ASM on plant growth** (plant height, leaf surface area) and ***Ea* propagation**. These data will then be processed using ImageJ software.

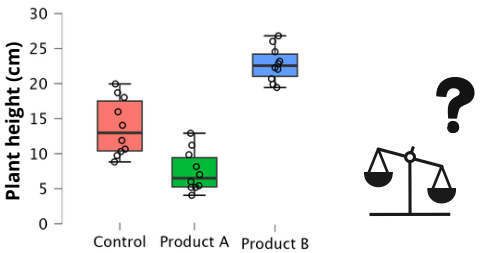


2 Screening hormone-like products affecting the growth-defense trade-off

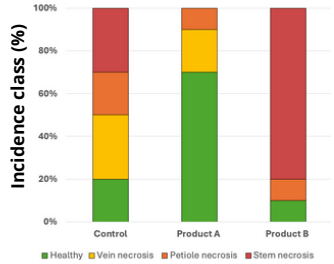
In parallel with this initial experiment, a second one is being conducted in a greenhouse to **examine a dozen of hormone-like products** (or inhibitors of these hormones) that **may influence plant growth, the propagation of *Ea*, or both**. The goal is to **select two or three products of interest** with distinct effects for further in-depth investigations.



Potential results



1.Evaluation of the potential effect of different products on plant growth



2. Examination of the potential effect of different products on susceptibility to *Ea*

3 Next experiment: In-depth analysis of selected products

In this final experiment, which combines aspects of the two previous ones, **we will analyze the selected products** (2) **in greater detail**, similar to how we examined ASM **using the Phenobean robot** (1). This will enable us to track the effects of these selected hormone-like products on both growth and susceptibility to *Erwinia amylovora* **under highly controlled environmental conditions.**

Perspectives This work will allow us to better understand the growth-defense tradeoff. Ultimately, we can reason more efficiently the use of PRI in orchards. Recent findings from our team indicate that abotic factors affect the effectiveness of PRI. Environmental factors, such as light quantity and quality, are also known influence growth and immunity by affecting hormonal balances (Campos et al., 2016 ; Hou et al., 2021). Using Phenobean, we will also explore how the environment may impact the growth defense tradeoff.

Brisset et al. 2000. European Journal of Plant Pathology 106, 529–536.
Campos et al. 2016. Nature Communications 7, 12570.
Hou et al. 2021. Nature Plants 7, 1078–1092.
Huot et al. 2014. Molecular Plant 7, 1267–1287.
Marolleau et al. 2017. Frontiers in Plant Science 8.
Warneys et al. 2018. Frontiers in Plant Science 9.

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