Impact of phytohormone levels and virus-encoded factors on the fitness of insect vectors of viruses, virus transmission efficiency, and the three-way interaction between plants, viruses, and insects

Plant hormones play a role in plant growth, development, and defence against pests and pathogens. Their level in the plant may be important for complex interactions with insects and transmitted by them viruses. Among the most important phytohormones are salicylic acid (SA), jasmonic acid (JA), ethylene (ET) and abscisic acid (ABA). It is not entirely clear how impaired phytohormones synthesis affects complex plant-insect-virus interactions. The role of viral genes in this regard is also not well explained.

This proposal aims to elucidate how plant characteristics associated with decreased phytohormones level influences insects being virus vectors, their performance, and virus transmission. This aspect of plant-herbivore interaction is not well understood, although a varied level of phytohormones in plants can be of great environmental importance, affecting the dispersal of insect pests and the virus transmission efficiency. The pathosystem to be studied will consist of tomato, aphid (*Myzus persicae*), and two virus species: cucumber mosaic virus (CMV, *Bromoviridae* family) and potato virus Y (PVY, *Potyviridae* family).
We hypothesise that insect behaviour, including this associated with plant virus transmission, depends on the level of important phytohormones and virus-encoded factors and that decreased level of phytohormones can significantly change plant cues recognised by insect pests vectoring viruses, especially when the plant is infected by virus.

Comprehensive analyses allowing the understanding of these three-way interactions, combining insect behaviour/performance studies and plant omics approaches, are scarce, especially in the context of mutations causing a reduction of phytohormone synthesis and involvement of virus-encoded factors.
In this proposal, we will test plants with reduced phytohormone levels (JA, ET, ABA) caused by mutations in genes involved in their synthesis, together with plants without mutations. These plants will be exposed to insects and viruses. Also, virus-infected plants will be exposed to insects. Using such pathosystems, we will observe feeding preferences, orientation behaviour, the population size of insects, and virus transmission efficiency. Furthermore, we will study the reason for specific insect behaviour on these tested plants to answer the question of why they are more (or less) attractive for insects. To this end, we will analyse the volatiles emitted by such plants, metabolites content, and the defence-related gene expression using three high-throughput approaches: volatomics, metabolomics and transcriptomics. Additionally, we will test the role of chosen viral proteins in such three-way interactions between plants, aphids and viruses and determine how they modulate plant attractiveness to insects. Finally, changes in the aphid population size and their developmental rate, as well as their viral transmission rate in studied pathosystems, will be assessed.
Knowledge of mechanisms lying behind these interactions can help in the future to predict diseases outbreaks and to develop management practices. The proposed approaches will provide data linking plant chemistry with plant-associated community dynamics. Proposal results will provide a comprehensive insight into the relationships in this three-way system thanks to transdisciplinary approaches undertaken (reverse genetics, virology, plant chemistry, omics analyses, entomology, insect behavioural characteristics).

The results of the project will allow us to answer questions: 1. What is the plant attractiveness toward insect when the synthesis of phytohormones important in plant defence is reduced? 2. What are the outcomes of viral infection of plants with reduced synthesis of phytohormones? 3. Are virus-infected plants with a reduced level of phytohormones better host for insects? 4. How the reduction of phytohormones synthesis impacts viral transmission by aphids? 5. What is the impact of virus-encoded factors involved in insect viral transmission and plant defence suppression when the synthesis of tested phytohormones is affected? 6**.** What is the further effect of these virus-encoded factors on plant virus transmission and their aphid vectors performance?