NitroDefenses

Study of nitrogen status and plant resistance inducers (PRI) interactions for the best trade-off between apple tree productivity and immunity

Keywords: Apple tree, Plant Resistance Inducers, Nitrogen

Grant: 3 years 50% INRAE-BAP (acquis) 50% Région Pays de la Loire (requested)

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PhD school : EGAAL« Écologie, Géosciences, Agronomie, ALimentation ».

Application: https://theses.doctorat-bretagneloire.fr/egaal/copy_of_theses-2020

Until: 21st June 2021.

Socio-economic and scientific context:

Use of plant resistance inducers (PRI) are one of the crop protection strategies mobilized to reduce the use of pesticides (Walters et al. 2013; doi:10.1093/jxb/ert026). Some PRI perform well in controlled conditions, but their efficiencies are often reduced in field systems. Field/orchard environmental conditions and crop management affect plant physiological status and therefore probably modify their receptiveness and/or response to PRI treatments. In particular, nitrogen fertilisation impacts on PRI efficiency and its consequences on plant immunity have not yet been deeply investigated.

The scientific challenge of the PhD project is to understand the **interactions between nitrogen and PRI** induced resistance. At the socioeconomic level, it is to establish a nitrogen fertilisation strategy to maximise plant induced resistance as well as a sustainable production. The PhD project focuses on apple trees, a culture with the highest treatment frequency index and under the threat of the ban of massively used fungicides as soon as 2025.

Scientific aims and research questions:

Several PRI perform well in controlled conditions against 3 main apple tree bioagressors, *Venturia inaequalis* (scab), *Erwinia amylovora* (fire blight) and *Dysaphis plantaginea* (rosy apple aphids) with significant but unsatisfactory protective effect in orchards. In particular, nitrogen availability is likely to impact PRI efficiency because (i) a high nitrogen status (N+) favours primary metabolism and plant growth, as well as susceptibility to pests in the case of apple trees, and on the other hand (ii) low N status (N-) is in favour of the secondary metabolism on which many apple tree defence mechanism rely.

Q1: How plant nitrogen status and PRI interact and modulate apple tree immunity?

The aim of the project is to verify if under nitrogen limitation, secondary metabolism pathways are induced and could i) amplify, ii) extend and iii) increase the persistence of plant defences effectors induced by PRI.

Q2: Which nitrogen regime, in combination with PRI, could optimize the apple tree growth/defence trade-off?

As N limitation impairs tree growth, the second aim of the project is to identify a nitrogen regime allowing the best compromise between plant growth and induced defences that would lead to increased PRI efficiency in orchard compatible with economically sustainable production. We hypothesise that a regime of alternate N limitation and fertilisation could optimize PRI efficiency and the tree growth / defence balance.

Methodological and technical approaches considered:

- Experimental work will be conducted on Gala fruit trees and two PRI with a significant effect against scab in orchard: Bion® a.i. acibenzolar-S-methyl (ASM) from the benzothiadiazole family (BTH), and Soriale® a.i. potassium phosphonate (LBG), respectively under approval or already approved for apple orchard use.

- Apple plant/tree culture under contrasted nitrogen regimes in controlled conditions, outdoor pots and orchards.

- Physiological assessment/phenotyping and pathological tests (*E. amylovora* - fire blight and *V. inaequalis* -scab).

- "-Omic" and targeted molecular phenotyping (transcription, metabolism, epigenetic and post-transcriptionnal regulations).

The project expenses will be covered by the ANR PPR project "CapZeroPhyto" that will also provide a scientific network including experts of apple trees genetic and inducible resistances as well as orchard management. The student will also benefit from interactions with the experts involved in the "Bestim" technological network ("Stimulate plant health in agroecological systems").

Scientific and technical skills required by the candidate

With a Plant Science Master 2 diploma (or equivalent), the candidate has strong/solid knowledge in plant physiology and/or phytopathology, plant cell and molecular biology. The candidate will organize and execute the different experimentations in controlled conditions and orchards. Familiarity with bioinformatics and/or statistic tools such as R will be appreciated. Good understanding of English, writing skills and appetite for team working are mandatory.