The Root-Knot Nematode Effector MiEFF18 Targets a Core Spliceosomal Protein and Facilitates Giant Cell Formation

J Mejias[a], J Bazin[b], N-M Truong[a,c], N Marteu[a], N Bouteiller[d], S Sawa[c], MD Crespi[b], H Vaucheret[d], P Abad[a], B Favery[a] & M Quentin[a]

[a] INRAE, Université Côte d'Azur, CNRS, ISA, F-06903 Sophia Antipolis, France ; [b] Institute of Plant Sciences Paris-Saclay (IPS2), CNRS, INRA, Universités Paris-Sud, Evry, Paris-Diderot, Sorbonne Paris-Cité, Université Paris-Saclay, 91405 Orsay, France ; [c] Graduate School of Science and Technology, Kumamoto University, Kumamoto 860-11 8555, Japan; [d] Institut Jean-Pierre Bourgin, INRA, AgroParisTech, CNRS, Université Paris-Saclay, 78026 Versailles Cedex, France

Scientific part

Meloidogyne incognita is a root-knot nematode (RKN) that triggers an intimate relationship with its host plant. After penetrating the plant root, Meloidogyne species secrete effector proteins synthesized from esophageal glands, via their stylet, into the host cells. RKN nematode effectors reprogram vascular root cells to induce the formation of a feeding structure consisting of five to seven giant cells. RKN effectors may target diverse subcellular compartments and manipulate essential developmental processes such as cell cycle, plant defenses, transcriptional regulations or phytohormones signaling, leading to the formation of the giant cells. MiEFF18 was identified as a putative effector using genomic and transcriptomic data, combined with in situ hybridization. We characterized a secreted root-knot nematode core effector, MiEFF18, which target the nucleus of the plant cell. A yeast two-hybrid approach identified its plant targets, the nuclear ribonucleoproteins Sm in tomato and Arabidopsis. Sm are essential components of the spliceosome, a complex involved in pre-RNA splicing. We showed that MiEFF18 alters Sm functions in alternative splicing and in sense transgene post-transcriptional gene silencing. Moreover, MiEFF18 overexpression leads to the modification of the expression of genes important for the ontogenesis of giant cells, notably those involved in microtubule cytoskeleton reorganization and cell cycle regulation. Finally, we demonstrated that the inactivation in plants of Sm leads to a loss of susceptibility to root-knot nematodes.

Technics/Tools

Knowing that around 400 root-knot nematode effectors are secreted during the interaction, a user-friendly tool to rapidly screen effectors that could impact plant physiology when they are overexpressed in planta was needed. Indeed, usual generation of stable Arabidopsis transgenic lines to overexpress a candidate effector in planta is time-consuming. To alleviate this problem, using engineered RNA plant virus to overexpress a foreign protein (example: GFP fusions) in planta could be a promising alternative. Moreover, these engineered viruses could infect many crops of interest such as Solanaceae. In plants, the Tobacco Rattle Virus (TRV) is commonly used as a tool to induce post-transcriptional gene silencing on plant transcripts. During my PhD and inspired by old works about TRV, I've engineered TRV replicons to allow systemic protein overexpression in N. benthamiana. I've studied the kinetics and spread of a modified TRV-GFP virus in N. benthamiana. I've tested if virions carrying a different genome are able to infect the same plant cells in order to understand if interactomic bi-molecular approaches tools can be apply to Tobacco Rattle Virus overexpression system. I will also discuss if the limit size of the transgene can be used in those replicons. Recently, a team from "Université du Quebec à Montréal" generate a new Barley Stripes Mosaic Virus (BSMV) system that promises overexpression of two large proteins at the same times and in 17 different plant species!!
Future application of "Plant virus as a tool to overexpressed proteins" should offers many possibilities in plant pathogen interaction field.