



**HAL**  
open science

## Virus-Induced Gene Silencing: Hush Genes to Make Them Talk

Vincent Courdavault, Sébastien Besseau, Audrey Oudin, Nicolas Papon,  
Sarah Ellen O'connor

► **To cite this version:**

Vincent Courdavault, Sébastien Besseau, Audrey Oudin, Nicolas Papon, Sarah Ellen O'connor. Virus-Induced Gene Silencing: Hush Genes to Make Them Talk. *Trends in Plant Science*, 2020, 25 (7), pp.714-715. 10.1016/j.tplants.2020.02.013 . hal-02866622

**HAL Id: hal-02866622**

**<https://univ-angers.hal.science/hal-02866622>**

Submitted on 22 Aug 2022

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial 4.0 International License

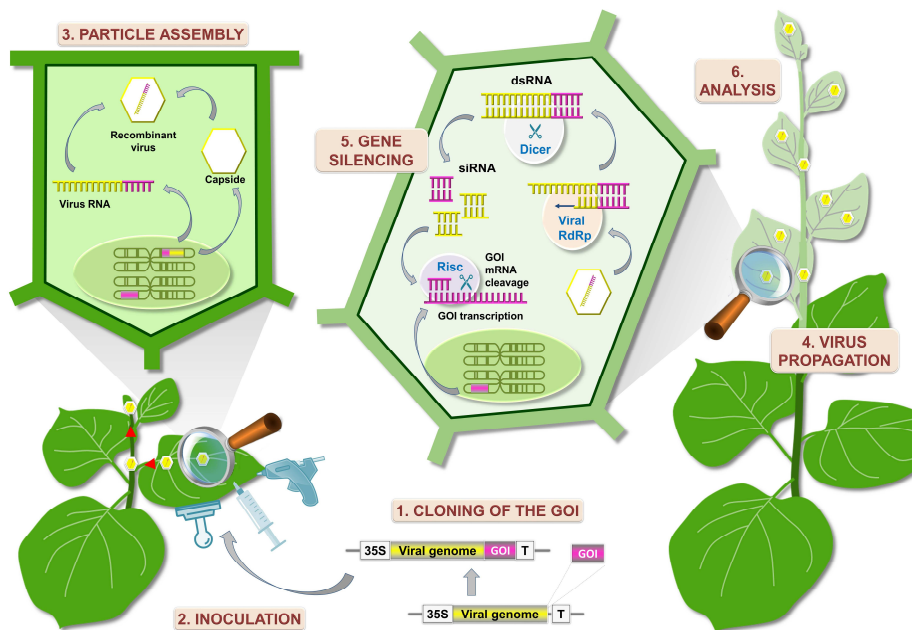
# Virus-induced gene silencing: hush genes to make them talk

Vincent Courdavault<sup>1,\*</sup>, Sébastien Besseau<sup>1</sup>, Audrey Oudin<sup>1</sup>, Nicolas Papon<sup>2</sup>, Sarah Ellen O'Connor<sup>3,\*</sup>

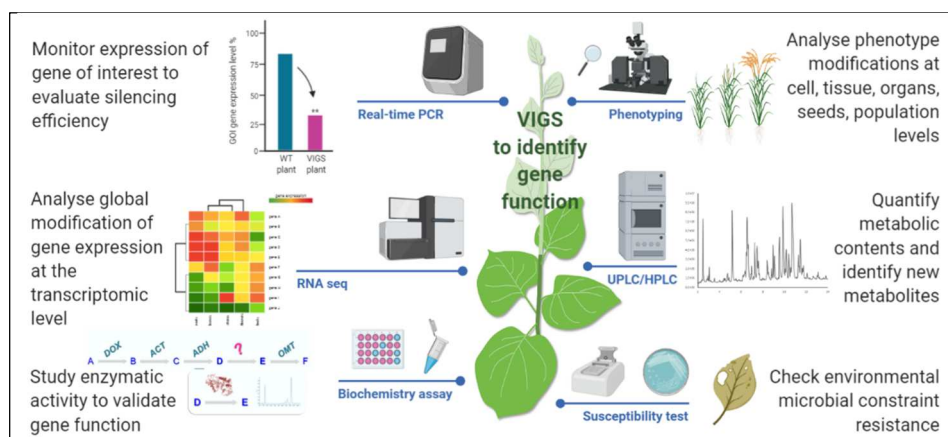
<sup>1</sup>Biomolécules et Biotechnologies Végétales, BBV, EA2106, Université de Tours, Tours, France

<sup>2</sup>Groupe d'Etude des Interactions Hôte-Pathogène, GEIHP, EA3142, Université d'Angers, SFR 4208 ICAT, Angers, France

<sup>3</sup>Department of Natural Product Biosynthesis, Max Planck Institute for Chemical Ecology, Jena, Germany



Virus-induced gene silencing (VIGS) silences a gene of interest (GOI) by exploiting plant defense mechanisms against RNA viruses. A GOI fragment is cloned into a construct containing viral genome sequence [1] and then inoculated into plants [2], where viral particles are produced [3]. Through cell-to-cell movement using plasmodesmata and systemic progression via the phloem [4], viruses infect newly developing leaves and replicate. This involves the formation of dsRNA that is cleaved by plant DICER to release siRNA. siRNA are loaded in the multiprotein complex RISC and their antisense strand screen RNA in cells. Hybridization of this complex results in a specific RNA degradation (or translation repression) of viral RNA and endogenous GOI transcripts causing its silencing.



After 3-6 weeks, gene silencing efficiency is analysed by monitoring GOI expression in new aerial parts of silenced plants and plants transformed with empty vector. Gene function can be investigated by comparative studies in similar organs from both types of plants.

## Advantages

- One of the easiest, cost-effective and most efficient ways to study gene function *in planta*. Allows a reliable silencing of genes (up to 90%) in a short time period (routinely 2-3 weeks post-inoculation).
- Wide range of procedures of virus/viral genome inoculation (e.g. agroinfiltration, agrodrench, leaf rubbing, biolistic).
- Robust and straightforward protocols reported for model and non-model plants.
- Allows study of essential genes that cannot be knocked out.
- Large-scale VIGS experiments for EST library screening is possible.
- Comparison of gene function between different species with same constructs.
- May lead to DNA methylation and heritable transcriptional gene silencing

## Challenges

- Identification of a suitable virus and inoculation method in non-model plants: virus host specificity requires tool development
- Low level and/or non-uniform gene silencing can result in reduced phenotypic and/or metabolic alterations. Lack of observable phenotype can also result from functional redundancies between gene family members.
- Symptoms caused by virus propagation may mask phenotypic variations due to gene silencing.
- Gene silencing is mainly transient and does not allow long time-course studies
- Difficulties in specific silencing of individual isoforms encoded by large gene family members.
- Metabolic rerouting of biosynthetic intermediates impedes identification of the reaction catalyzed by products of silenced genes.

\*Correspondence:

[vincent.courdavault@univ-tours.fr](mailto:vincent.courdavault@univ-tours.fr); [oc Connor@ice.mpg.de](mailto:oc Connor@ice.mpg.de)

## Acknowledgments

© 2020 published by Elsevier. This manuscript is made available under the CC BY NC user license

<https://creativecommons.org/licenses/by-nc/4.0/>

We acknowledge funding from the EU Horizon 2020 research and innovation program (MIAMI project-Grant agreement N°814645), ARD2020 Biopharmaceutical program of the Région Centre Val de Loire (BioPROPHARM and CatharSIS projects), La Ligue Contre le Cancer (Yeast4LiFE), from le Studium (Consortium fellowship) and ERC 788301.

## Literature

1. Ratcliff, F. *et al.* (1997) A similarity between viral defense and gene silencing in plants. *Science* 276,1558–1560
2. Kumagai, M.H. *et al.* (1995) Cytoplasmic inhibition of carotenoid biosynthesis with virus-derived RNA. *Proc. Natl. Acad. Sci. U S A.* 92,1679–1683
3. Burch-Smith, T.M. *et al.* (2006) Efficient virus-induced gene silencing in *Arabidopsis*. *Plant Physiol.* 142, 21–27
4. Senthil-Kumar, M. *et al.* (2014) Tobacco rattle virus-based virus-induced gene silencing in *Nicotiana benthamiana*. *Nat. Protoc.* 9, 1549–1562
5. Ratcliff, F. *et al.* (2001) Technical Advance. Tobacco rattle virus as a vector for analysis of gene function by silencing. *Plant J.* 25, 237–245
6. Dommès, A.B. *et al.* (2019) A. Virus-induced gene silencing: empowering genetics in non-model organisms. *J. Exp. Bot.* 70, 757–770
7. Bond, D.M. *et al.* (2015) Epigenetic transitions leading to heritable, RNA-mediated de novo silencing in *Arabidopsis thaliana*. *Proc. Natl. Acad. Sci. U S A.* 112, 917–922
8. Liu, E. *et al.* (2008) Optimized cDNA libraries for virus-induced gene silencing (VIGS) using tobacco rattle virus. *Plant Methods* 4, 5
9. Pacak, A. *et al.* (2010) Investigations of barley stripe mosaic virus as a gene silencing vector in barley roots and in *Brachypodium distachyon* and oat. *Plant Methods* 6, 26
10. Sasaki, S. *et al.* (2010) Efficient virus-induced gene silencing in apple, pear and Japanese pear using Apple latent spherical virus vectors. *Plant Methods* 7, 15