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► To cite this version:

Sophie Trouvelot, Christelle Guillier, Lucile Jacquens, Antonin Douillet, Samuel Marchat, et al.. Metabolomic and cytological approaches to better understand grapevine trunk diseases disorders. 10th IWGTD, 2017, REIMS, France. hal-03124072

HAL Id: hal-03124072

<https://hal.univ-reims.fr/hal-03124072v1>

Submitted on 28 Jan 2021

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Metabolomic and cytological approaches to better understand grapevine trunk diseases disorders

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1 Context

Grapevine trunk diseases (GTDs) are devastating diseases involving xylem-inhabiting fungi. Among them, **Esca** and **Botryosphaeria dieback** affect vineyards in major worldwide grape-producing areas. The causal fungi **alter the woody tissues** and could **produce toxins** that **disturb the plant physiology**, leading to chronic or apoleptic leaf symptoms. The unique effective fungicide against these diseases, sodium arsenite, is now prohibited because of toxicity. As GTDs are complex and still partly unknown, the identification of protection strategies remain a deadlock. **Global and targeted approaches** were therefore conducted to **get new information on the impact of the diseases and sodium arsenite treatment on grapevine metabolism, development and physiology**.

2 Methodology

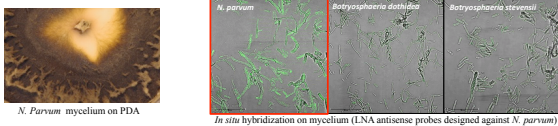
Metabolomics (GC-MS and FT-ICR-MS) was used to highlight the impact of the disease / sodium arsenite treatment on the plant metabolic pathways and to obtain the associated metabolite signatures.

Imaging approaches including **histological observations by epifluorescence, scanning- and transmission-electron microscopy** were used to observe grapevine responses to disease / treatment, and pathogen localization.

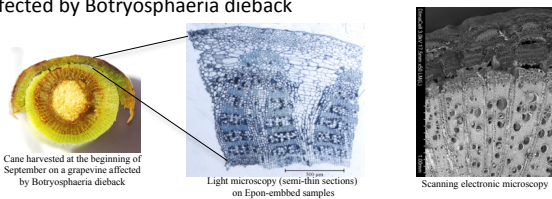
3 Main results

A better knowledge of plant / pathogen interaction (France Agrimer & BIVB-CR BFC projects)

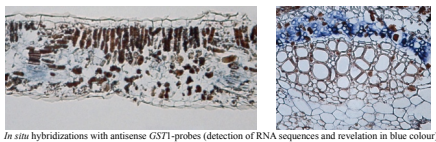
(1) Development of a method for *Neofusicoccum parvum* detection



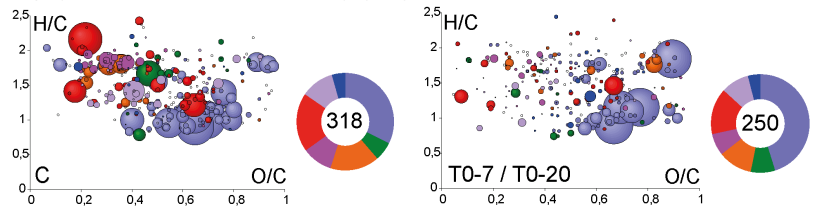
(2) Evidence of alteration of secondary histogenesis in canes affected by Botryosphaeria dieback



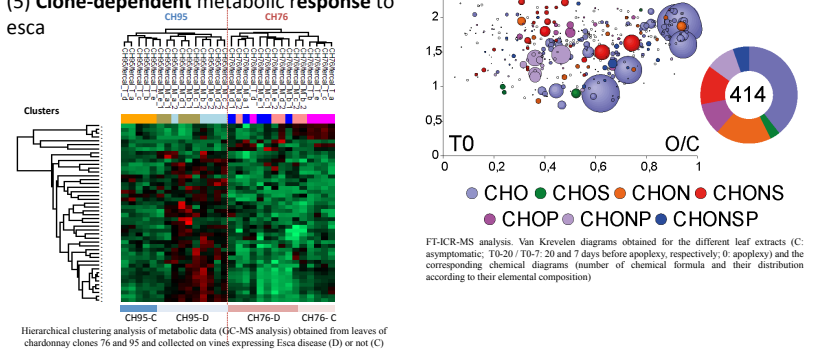
(3) Specific localization of the *GST1* (glutathione-S-transferase; role in detoxication process) expression in the phloem of esca-symptomatic leaves



(4) Specific metabolic signatures of leaves from asymptomatic and symptomatic Esca-grapevines (before and at time of apoplexy occurrence)

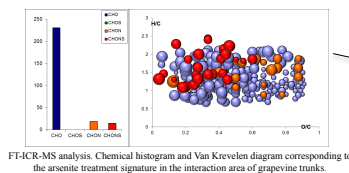


(5) Clone-dependent metabolic response to esca

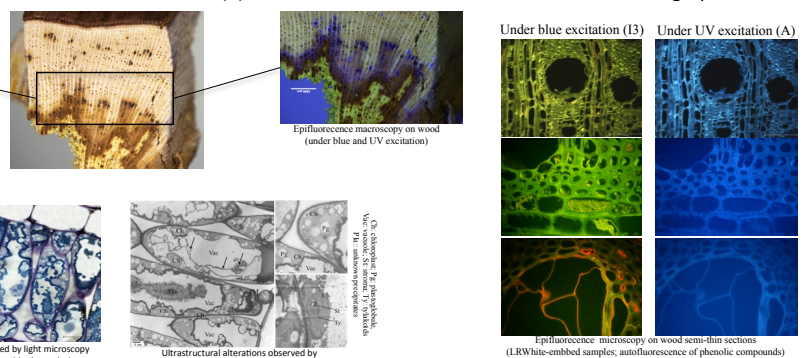


Impact of sodium arsenite (Asn) treatment (Casdar V1301 Project)

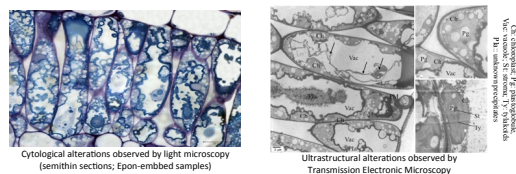
(1) Determination of a trunk metabolic signature of Asn-treated grapevines



(3) Plant defense reactions in trunk of Asn-treated grapevines



(2) Highlighting of vacuolar and chloroplastic alterations in leaves of Asn-treated grapevines



4 Conclusion

All these experiments were integrated into research projects combining **multidisciplinary approaches**. They allowed us to **shape tools** for further experiments and to **progress in the knowledge of the impact of GTDs and Asn treatment** on grapevine. All these results constitute precious information to define further experiments with the objective to find solutions to prevent - otherwise to restrain- such diseases in order to ensure the vineyard sustainability.

Acknowledgement: Special thanks to BIVB, Conseil Régional de Bourgogne Franche-Comté and Feder for financial support; to Guillaume Morvan for helpful discussions; to DimaCell for help in microscopy observations and PFCV for GC-MS analyses.