SmartGrape - Early Detection of Bois Noir in Vineyards

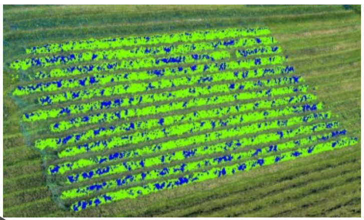
Kathleen Mackie-Haas[1], Lukas Bertschinger[2], Sergio Ramos Castro[3], Lionel Christen[1], Christophe Debonneville[4], Christian Geckeler[5], Jeremiah Huggel[3], Patrik Kehrli[4], Stefano Mintchev[5], Salome Schneider[2], Meredith C. Schuman[3]
[1]Agroscope, 8820 Wädenswil, Schweiz; [2]Weinbauzentrum Wädenswil, 8820 Wädenswil; [3]Universität Zürich, 8006 Zürich; [4]Agroscope Changins, 1260 Nyon; [5]Eidgenössische Technische Hochschule Zürich, 8092 Zürich

Introduction

- **Cause and Transmission:** Bois Noir (BN) is caused by the phytoplasma ***Candidatus solani*** and transmitted by the leafhopper ***Hyalesthes obsoletus*** from undergrowth plants to grapevines (*Vitis vinifera*).
- **Symptoms:** leaf discoloration (red varieties - red, white varieties - yellow), rubbery and green stems, and shriveled or absent grapes. Symptoms can vary by intensity, grape variety and year.
- **Impact**: Up to 50% loss in yield. Infected plants cannot be cured, but symptom strength can vary.
- **Diagnosis Challenges:** Symptoms are exactly the same as Flavescence Dorée (FD, quarantine organism), requiring laboratory analysis for accurate differentiation.
- **Needs:** No direct control methods exist; early and systematic detection methods are urgently needed to support management and prevention.
- **Goal:** develop a robust package of innovative monitoring and early detection methods for BN disease. Test the transferability to FD.

Spectral Imaging

- BN infected vines were monitored over several years → Vines were tested prior to symptom development (early detection) and with clear visual symptoms.
- Data integration was performed to train machine learning models for categorizing diseased vines and highlighting distinguishing features.
- **Spectral imaging :** efficient mapping and estimation of the proportion of infected plants in the vineyard using drone hyperspectral imaging.
- The model was trained using manually categorized symptomatic pixels and subsequently applied to the entire dataset. The results shows the infected area.



Flight altitude: 20 meters.

Image acquisition: every 3 Meters.

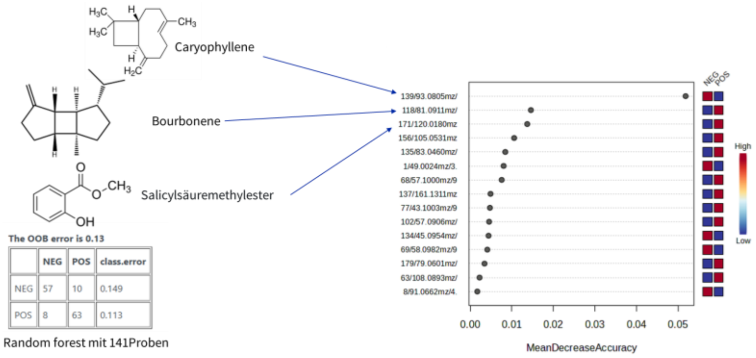
Red variety Zweigelt

79% accuracy rate after visual verification.

Stongly symptomatic vines Well detected.

Volatile Organic Compounds

- **Plant volatile compounds (VOCs)** of non-symptomatic and symptomatic vines were analyzed to identify potential biomarkers for early detection.
- Dataset : Zweigelt plot (n=167 positive, 167 control vines)
- **Plant volatile compounds:** The random forest model showed an OOB error of 0.13.



	NEG	POS	class.error
NEG	57	10	0.149
POS	8	63	0.113

Random forest mit 141Proben

→ **Three potential biomarkers** were identified:

- *Caryophyllene:* **Not detected** in infected plants.
- *Bourbonene:* Only **detected** in infected plants.
- *Methyl salicylate:* Only **detected** in infected plants.

→ *Methyl salicylate* was also detected in a small FD dataset of 30 symptomatic vines. This number is limited each year as officially all FD vines must be removed from the vineyard to prevent spreading a quarantine organism.

Discussion & Outlook

- Initial results are promising for VOCs and spectral imaging.
- Metabolomic analyses were also conducted and are currently under analysis.

For 2026 :

- Data analysis of Chardonnay and Pinot Noir before and after symptom development (conducted in 2025).
- Integration of our methods into one single tool.

Open questions :

- Will it be possible to detect the number of infected plants rather than the infected area?
- What are the respective effects of variety and plot on VOCs?

Summary: Several methods have been tested to identify Bois Noir in vineyards. Spectral imaging enabled detection of symptomatic leaves with over 79% accuracy. Three potential biomarkers were identified with the volatiles analysis. These promising results will need to be confirmed across multiple varieties and locations.