



Universität
Zürich ^{UZH}

ETH zürich

SmartGrape



EPPO Workshop 18th Nov 2025

Christian Geckeler



a)



b)



c)



d)



Jeremiah Hugel



<https://ag.dji.com/mavic-3-m>



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Landwirtschaft BLW

Image: Jeremiah Hugel (2024) MSc Thesis, UZH

Grapevine yellowing diseases: bois noir and flavescence dorée

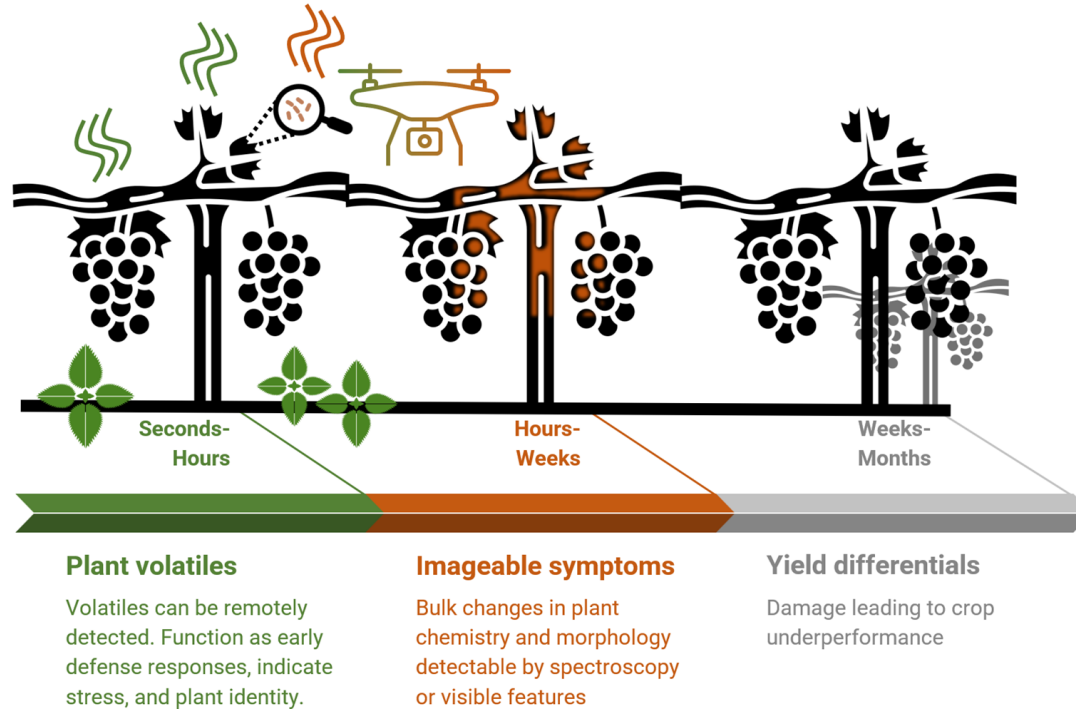


Abb. 2: Schwarzholzsymptome: Blattvergilbungen,
Traubenwelke und unvollständige Holzreife.

(FOTO: PAUL GUGERLI, ACW)

https://www.agroscope.admin.ch/agroscope/de/home/publikationen/suchen/_jcr_content/par/externalcontent.bitexternalcontent.exturl.pdf/aHR0cHM6Ly9pcnEuYyYydyB3NjB3ILmNoL2RILUNIL1BhZ2UvRW/luemVscHVbGirYXRpb24vRG93bmxyYVQ_ZW/luemVscHVbGirYXRpb25JZD0yMTE4NA==.pdf
<https://www.agroscope.admin.ch/agroscope/de/home/themen/pflanzenbau/pflanzenschutz/agroscope-pflanzenschutzdienst/geregelte-schadorganismen/quarantaeneorganismen/goldgelbe-vergilbung/flavescence-doree-symptomes-controles.html>

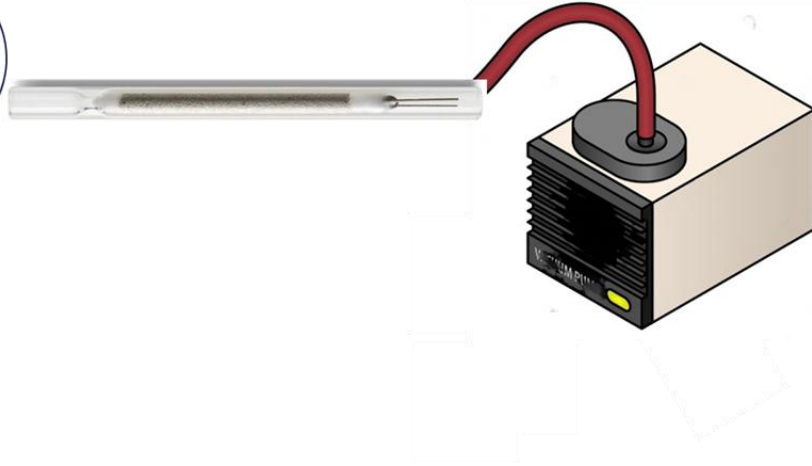
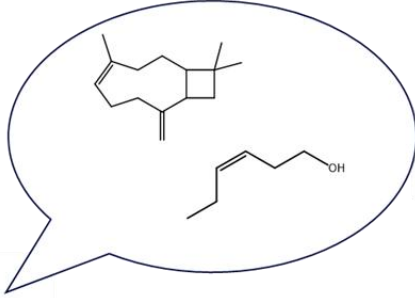
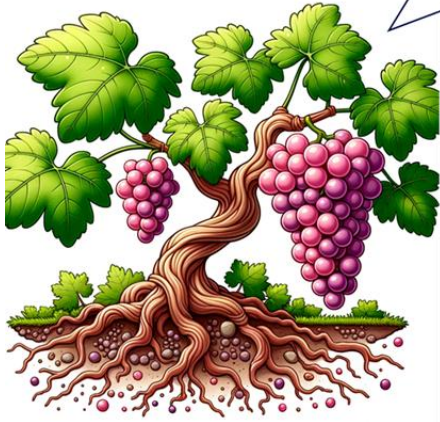
SmartGrape: toward systematic and early detection of invasive cicada-borne grapevine diseases





Linus Reichert

Classification of disease state *via* plant volatiles





Classification of disease state *via* plant volatiles





Plant volatile sampling and analytical measurement

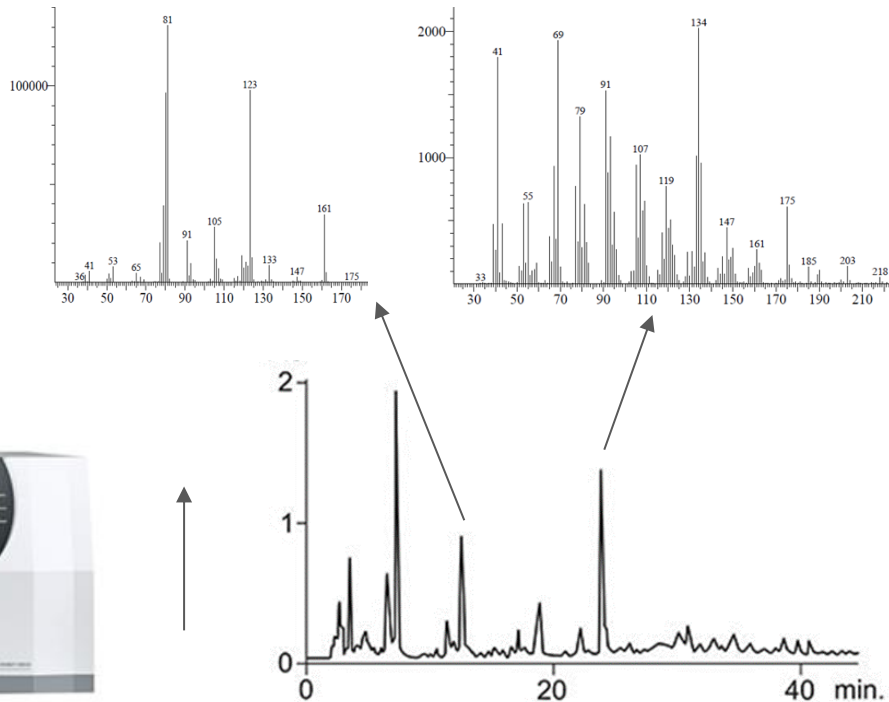
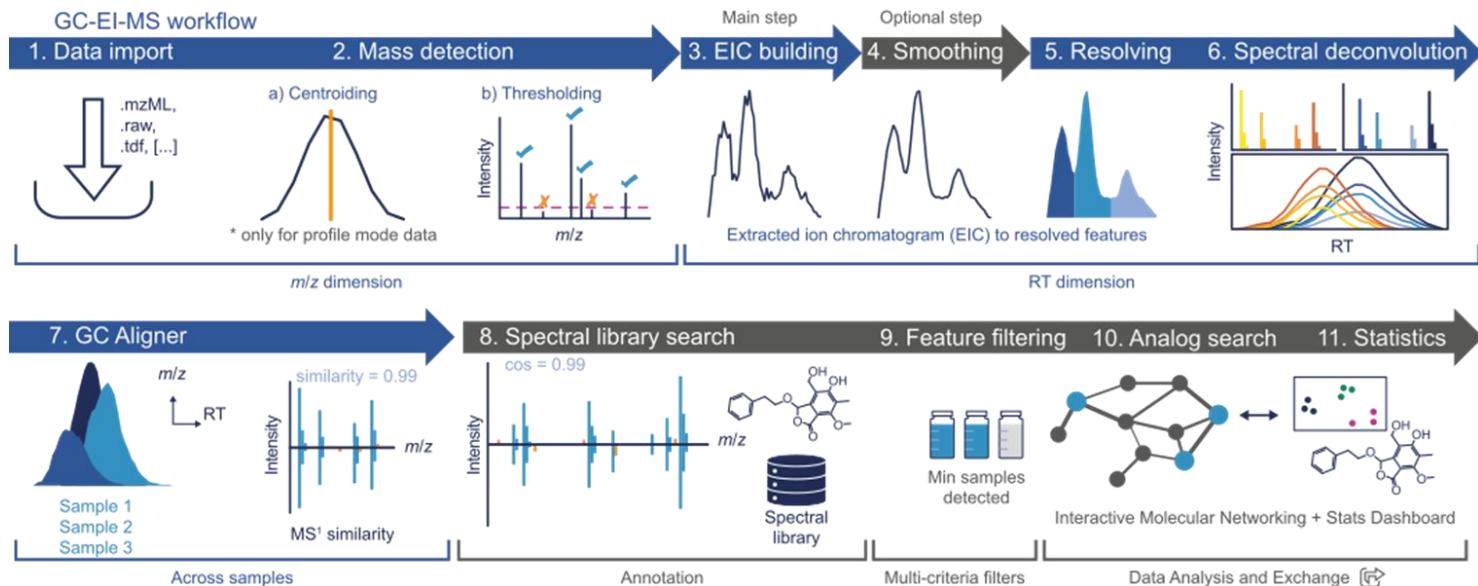


Illustration and photo: L. Reichert, images: Sigma-Aldrich, Shimadzu



Plant volatile biomarker discovery (open pipeline)



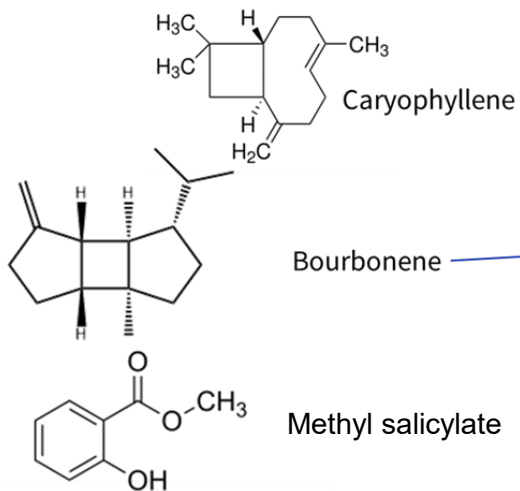
MZmine, Heuckeroth S et al. (2024) [doi:10.1038/s41596-024-00996-y](https://doi.org/10.1038/s41596-024-00996-y)
https://mzmine.github.io/mzmine_documentation/workflows/gcmsworkflow/gcms-workflow.html

<https://www.metaboanalyst.ca/>



Classification of bois noir disease in Zweigelt

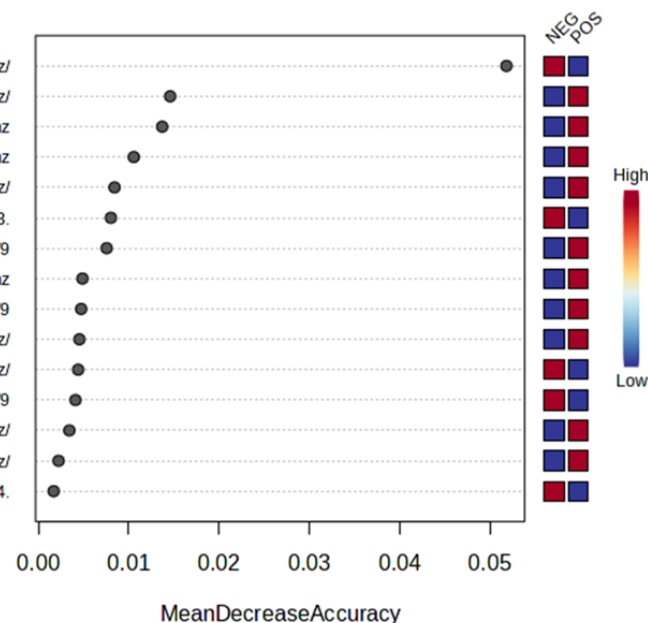
(Rütihof)



The OOB error is 0.13

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

139/93.0805mz/
118/81.0911mz/
171/120.0180mz
156/105.0531mz
135/83.0460mz/
1/49.0024mz/3.
68/57.1000mz/9
137/161.1311mz
77/43.1003mz/9
102/57.0906mz/
134/45.0954mz/
69/58.0982mz/9
179/79.0601mz/
63/108.0893mz/
8/91.0662mz/4.

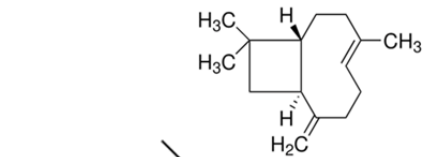
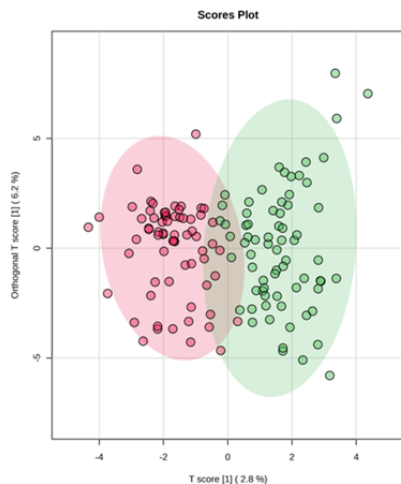


Random Forest classification

141 samples from one vineyard, 2024 large-scale pilot

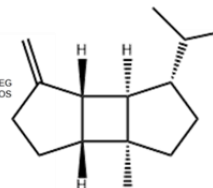


Classification of bois noir disease in Zweigelt (Rütihof)



Caryophyllene

139/93.0805mz/



Bourbonene

118/81.0911mz/

156/105.0531mz

137/161.1311mz

171/120.0180mz

135/83.0460mz/

3/93.0622mz/4.

94/59.0624mz/1

69/58.0982mz/9

68/57.1000mz/9

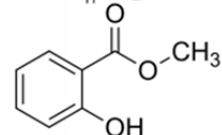
102/57.0906mz/

130/81.0885mz/

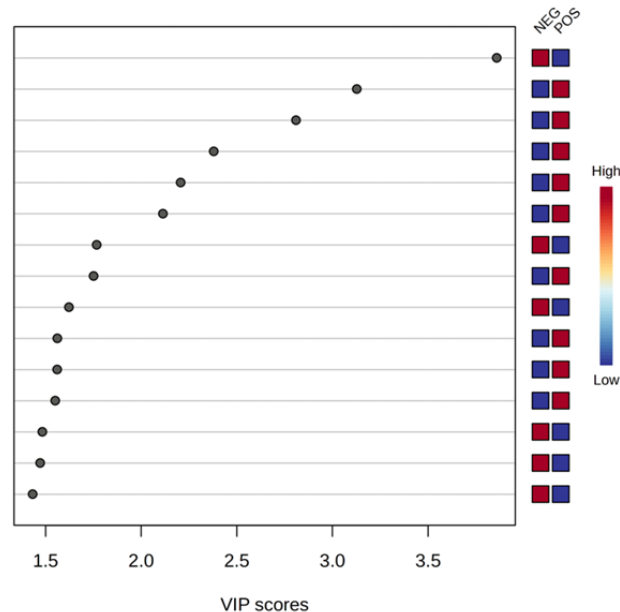
184/56.0985mz/

152/93.0834mz/

7/75.0245mz/4.



Salicysäuremethylester

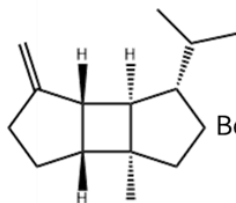
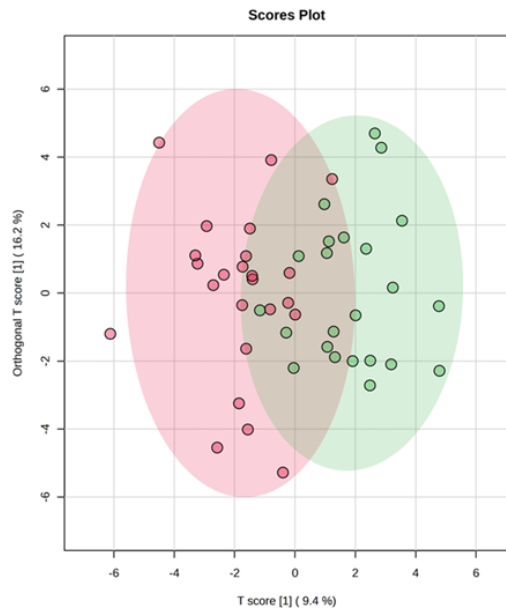


sPLSDA = sparse partial least squares regression-discriminant analysis
141 samples from one vineyard, 2024 large-scale pilot



Classification of bois noir disease in pinot noir

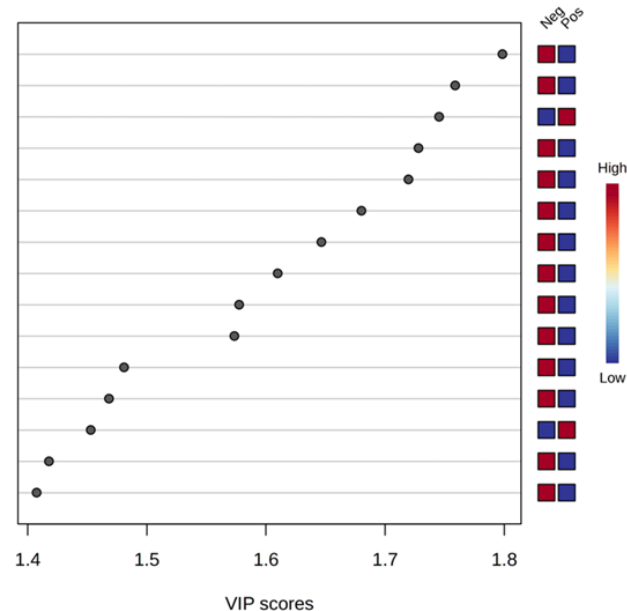
(Weinmanufaktur, Weinbauzentrum)



Bourbonene



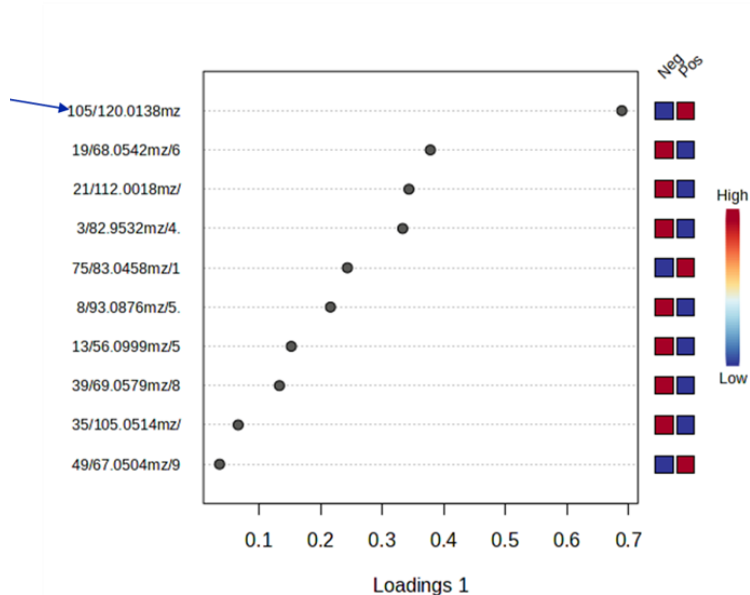
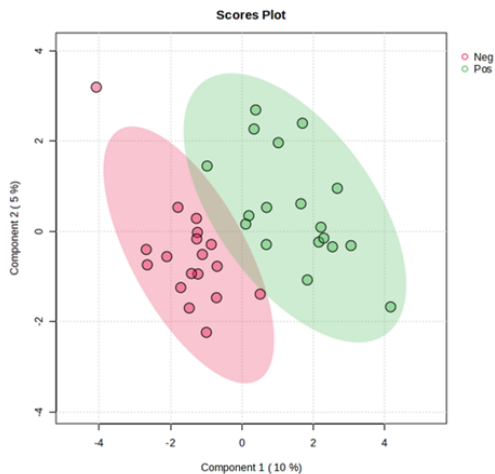
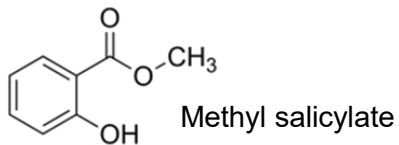
52/57.0999mz/1
8/91.0749mz/5.
60/81.0979mz/1
33/57.1000mz/8
4/91.0747mz/4.
26/104.0522mz/
90/79.0774mz/1
2/281.0564mz/3
85/120.0426mz/
92/94.0505mz/1
82/43.0934mz/1
69/60.0507mz/1
38/41.1000mz/9
71/77.0116mz/1
59/106.0483mz/



oPLSDA = orthogonal partial least squares regression-discriminant analysis
ca. 45 samples from two vineyards, 2024 small-scale pilot



Classification of flavescente dorée in chardonnay (Cully)



sPLSDA = sparse partial least squares regression-discriminant analysis
37 samples from one vineyard, 2024 small-scale pilot



Classification of disease state *via* plant volatiles

- Some overlap in volatiles indicative of bois noir in Zweigelt, pinot noir
- Approach looks transferable to flavescence dorée
- More data yield better results: Currently analyzing a larger dataset across multiple varieties and vineyards from 2025
- Early detection requires more data: Testing in 2025 full-season dataset
- Results indicate that we can derive biomarkers (a few indicative molecules)

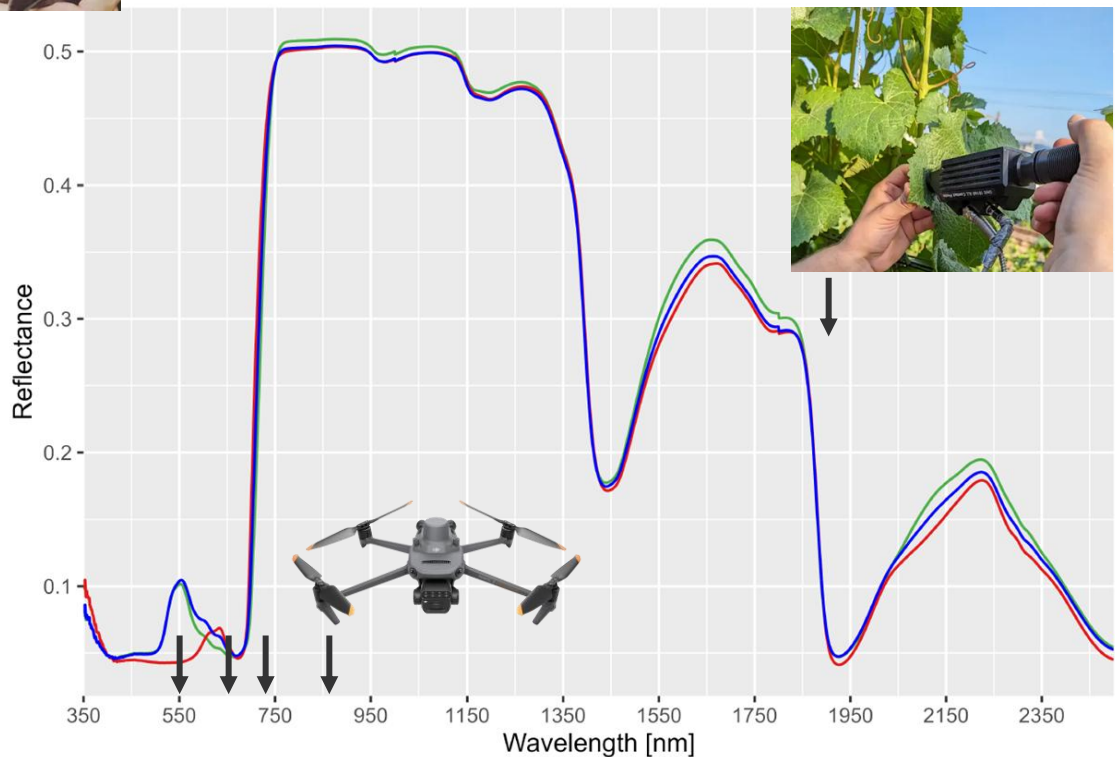
Outlook





Image analysis and spectroscopy to detect symptoms

Jeremiah Huggel



Type

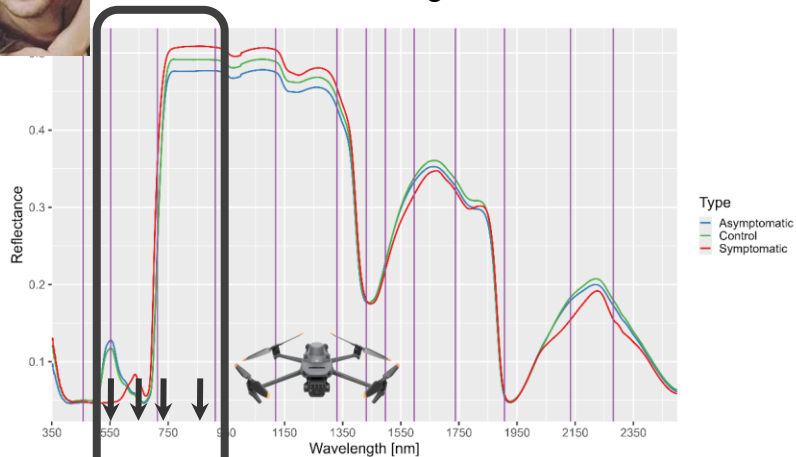
- Control
- Heavily Symptomatic
- Mildly Symptomatic



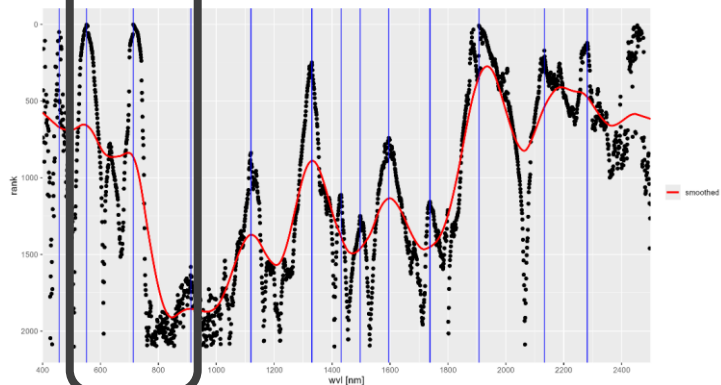


Image analysis and spectroscopy to detect symptoms

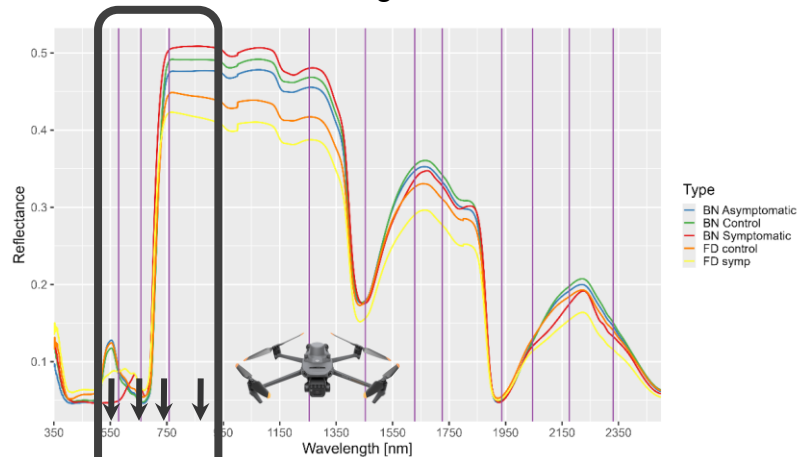
«Ideal» Wavelengths BN



Relevance of Wavelengths (blue lines indicate maxima)



«Ideal» Wavelengths with FD



Relevance of Wavelengths (blue lines indicate maxima)

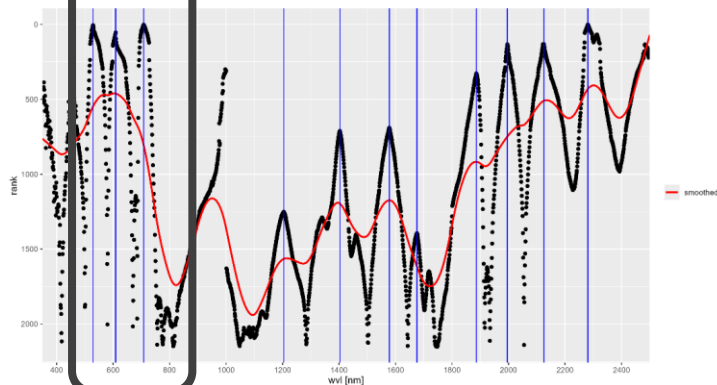




Image analysis and spectroscopy to detect symptoms

Wavelengths:

- Green – 550nm
- Red – 650nm
- Red Edge (RE) – 740nm
- Near Infrared (NIR) – 860nm
- RGB



Close-up – RGB



20m - RGB





Image analysis and spectroscopy to detect symptoms



Rot

Grün



NIR



Red Edge



Falschfarbenbild (R: RE, G: 4*Rot, B: 3*Grün)

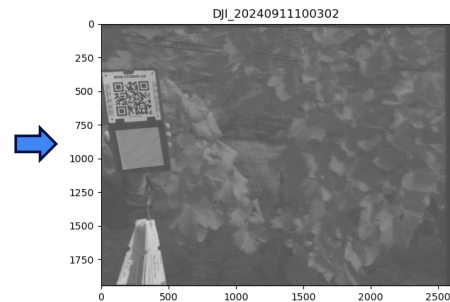
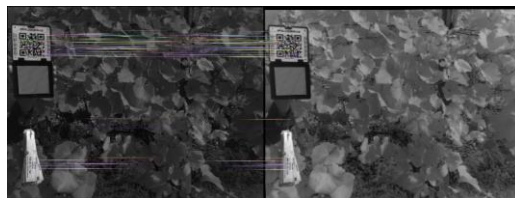
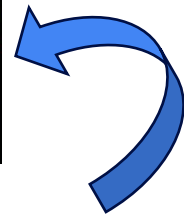
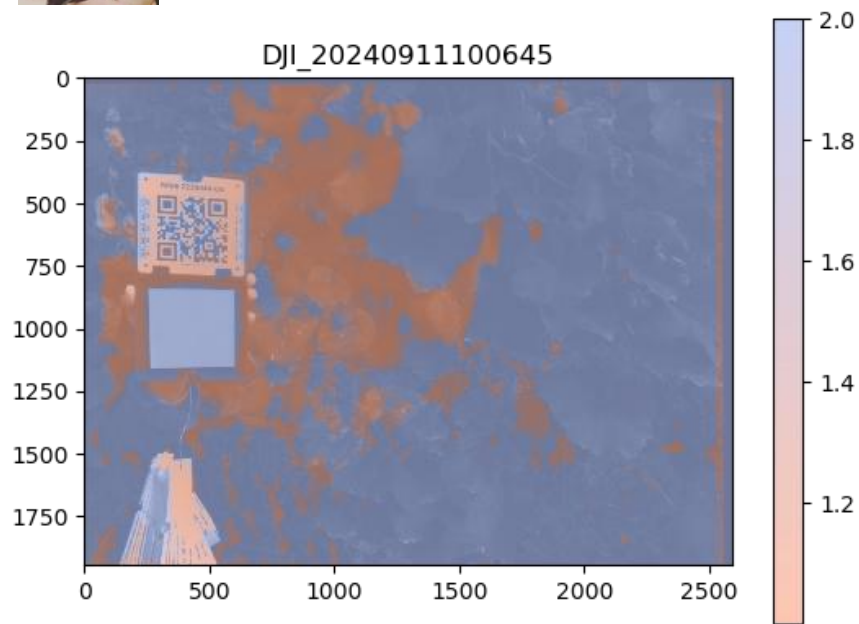




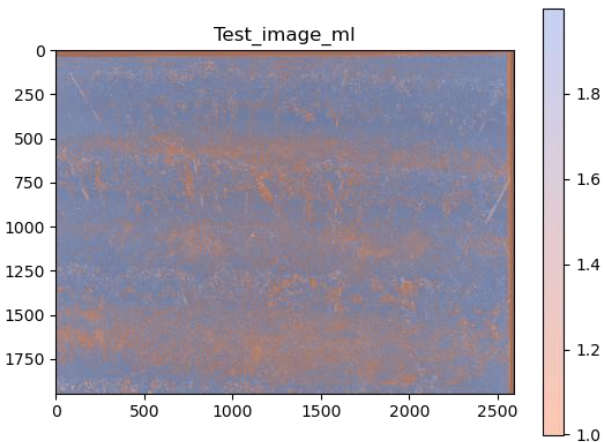
Image analysis



82% accuracy

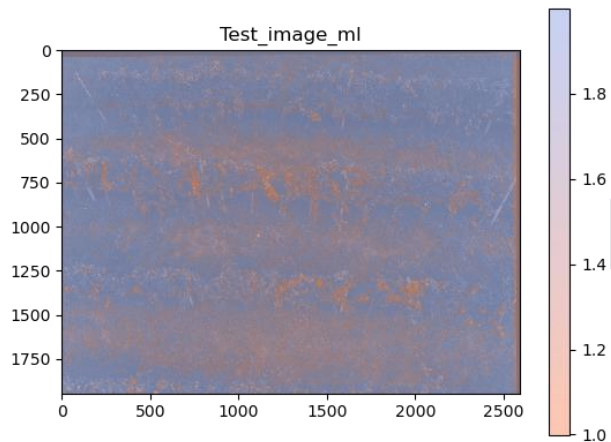


ML with wavelengths



Input:
- Red, Green, Red Edge, NIR

ML with indices (filtered)



Input:
- Red, Green, Red Edge, NIR
- $NDVI = (NIR - Red) / (NIR + Red)$
- $ARI = (1/Green) - (1/Red\ Edge)$
- $GRVI = (Green - Red) / (Green + Red)$
- $ACI = (Green / NIR)$

Filtered / Signal enhanced

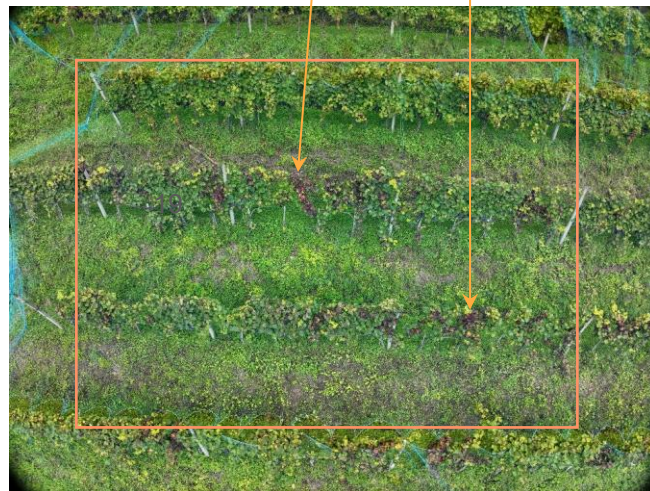
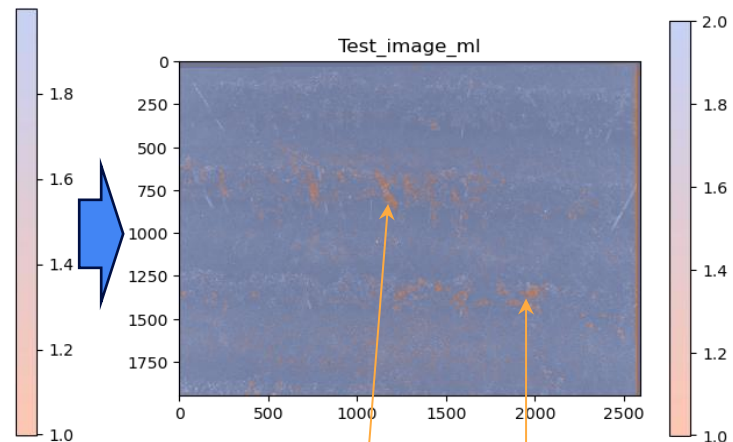




Image analysis and spectroscopy to detect symptoms

3D point cloud



55% symptomatic vines



32.4% symptomatic pixels



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Lionel Christen
Lukas Bertschinger
Kathleen Mackie-Haas
Patrik Kehrli
Christophe Debonneville**

Agroscope

Thank you!



**Winegrowers: Rütihof, Weinmanufaktur,
Weinbauzentrum, Meienberg, Höcklistein**



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Confédération suisse
Confederazione Svizzera
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Bundesamt für Landwirtschaft BLW