2 December 2025

Early Detection of Geminivirus Using Volatile Organic Compounds (VOCs) Sensor

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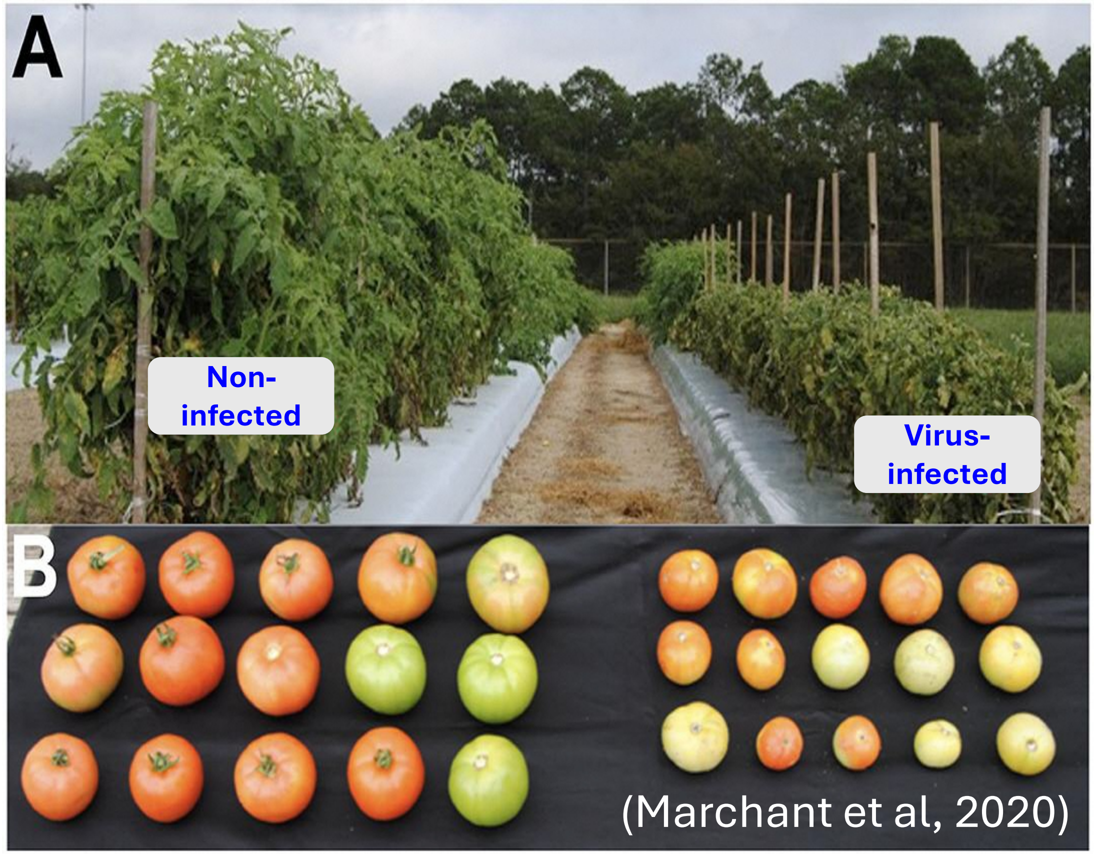
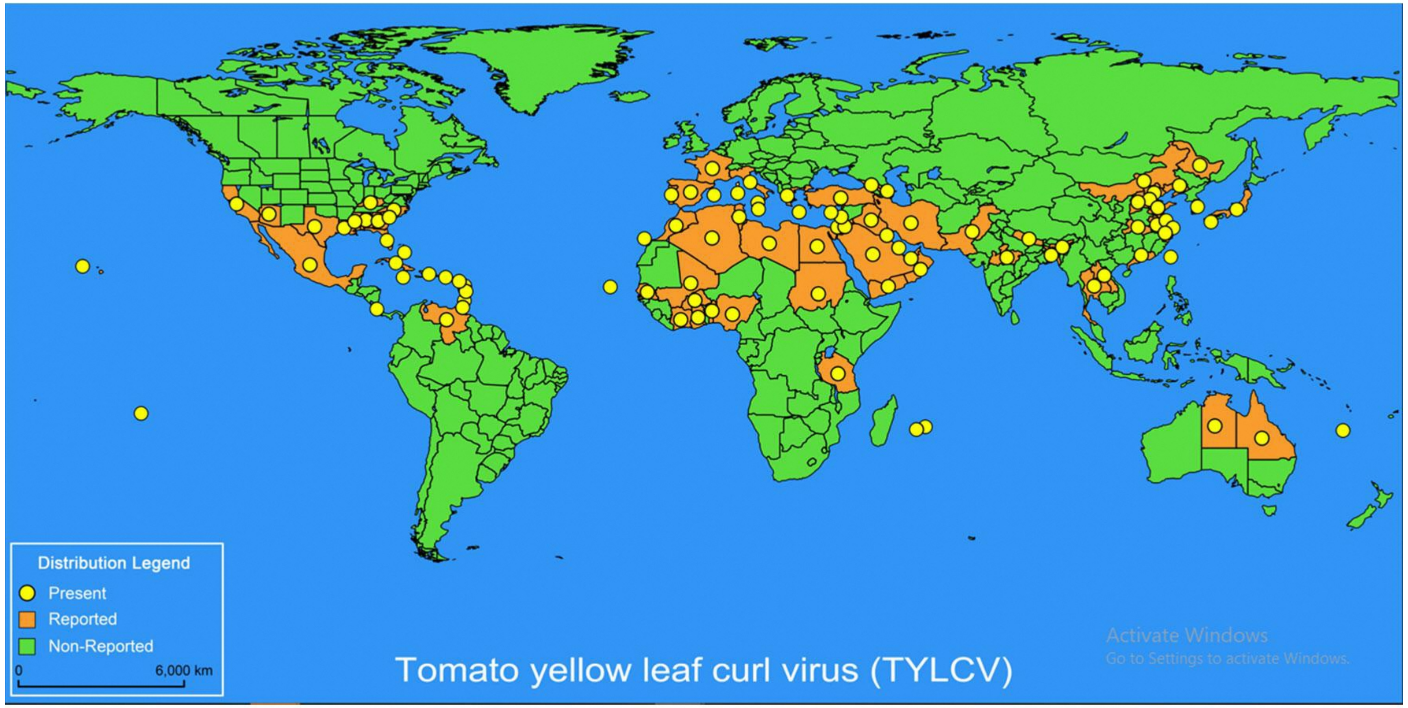
6th Shizuoka-Singapore Agrifood Forum (SSAFF6)

Geminivirus infection is a global threat

- Tomato Yellow Leaf Curl Virus (TYLCV) infection is a global threat that dramatically reduces productivity, leading to significant economic losses.
- Infected susceptible tomato cultivars can experience up to 100% yield loss (Levy *et al*., 2008).



(Marchant et al, 2020)



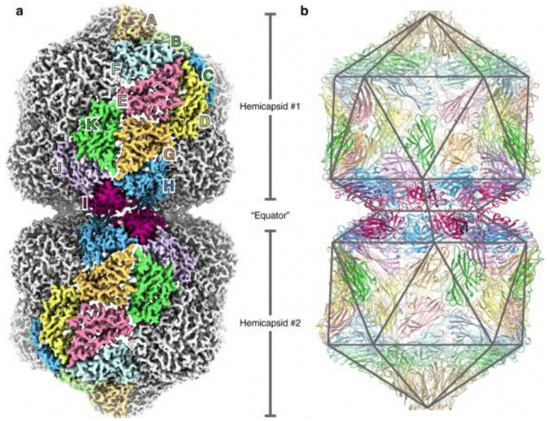
(El-Sappah et al, 2022)

- Need for early detection to prevent yield loss.

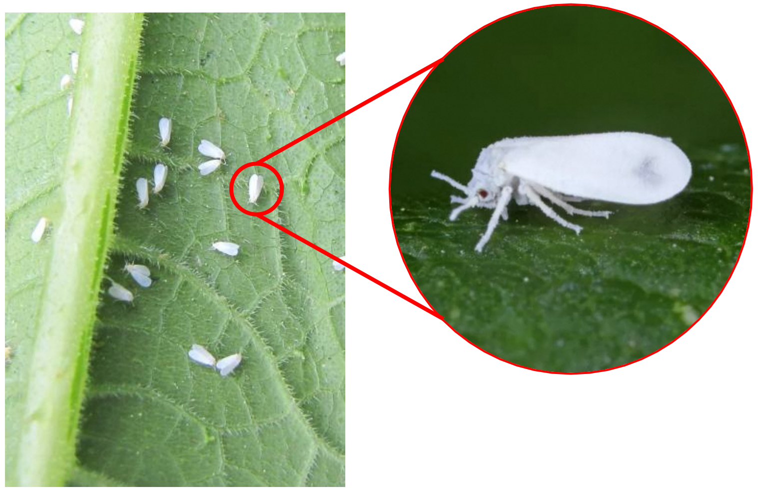
REPUBLIC POLYTECHNIC

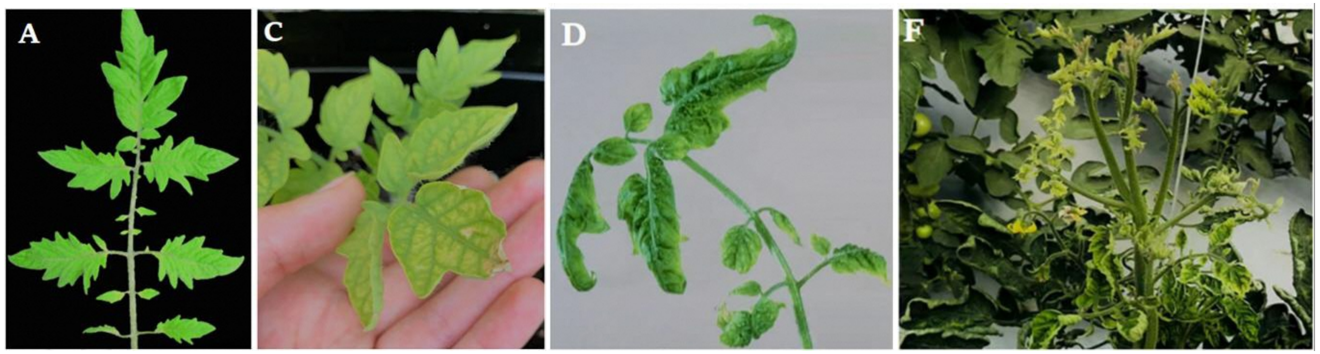
Tomato Yellow Leaf Curl Virus (TYLCV)

- DNA virus from genus Begomovirus, family Geminiviridae.
- Genome: Single circular single-stranded DNA (~2787 nt).
- Hosts: Tomato, eggplant, potato, tobacco, peppers.
- Transmitted by whitefly.
- Symptoms: Leaf curling, chlorosis, stunting, reduced fruit yield.
- Economic impact: Millions $$ lost annually.



Structure of Geminivirus.
(Hesketh et al, 2018)





Non-infected | Chlorosis | Leaf curling | Stunting

(El-Sappah et al, 2022)

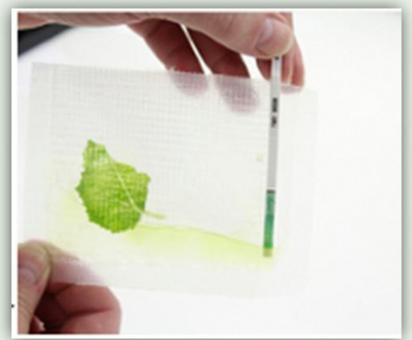
Current TYLCV detection methods

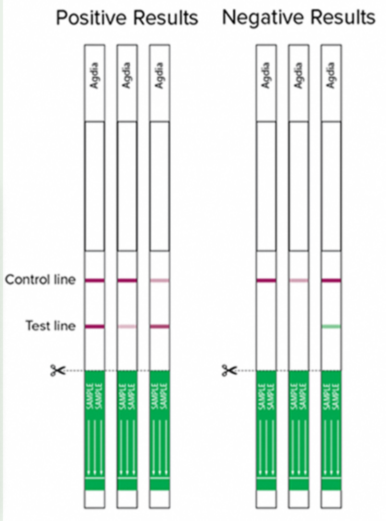
Visual inspection

- ✓ Immediate observation
- ✓ No special equipment required
- ✓ Almost zero cost
- ✗ Requires experience
- ✗ Low sensitivity and accuracy for early state infection
- ✗ Labour-intensive
- ✗ Subjective interpretation

Immunostrip® method

Commercialized Product



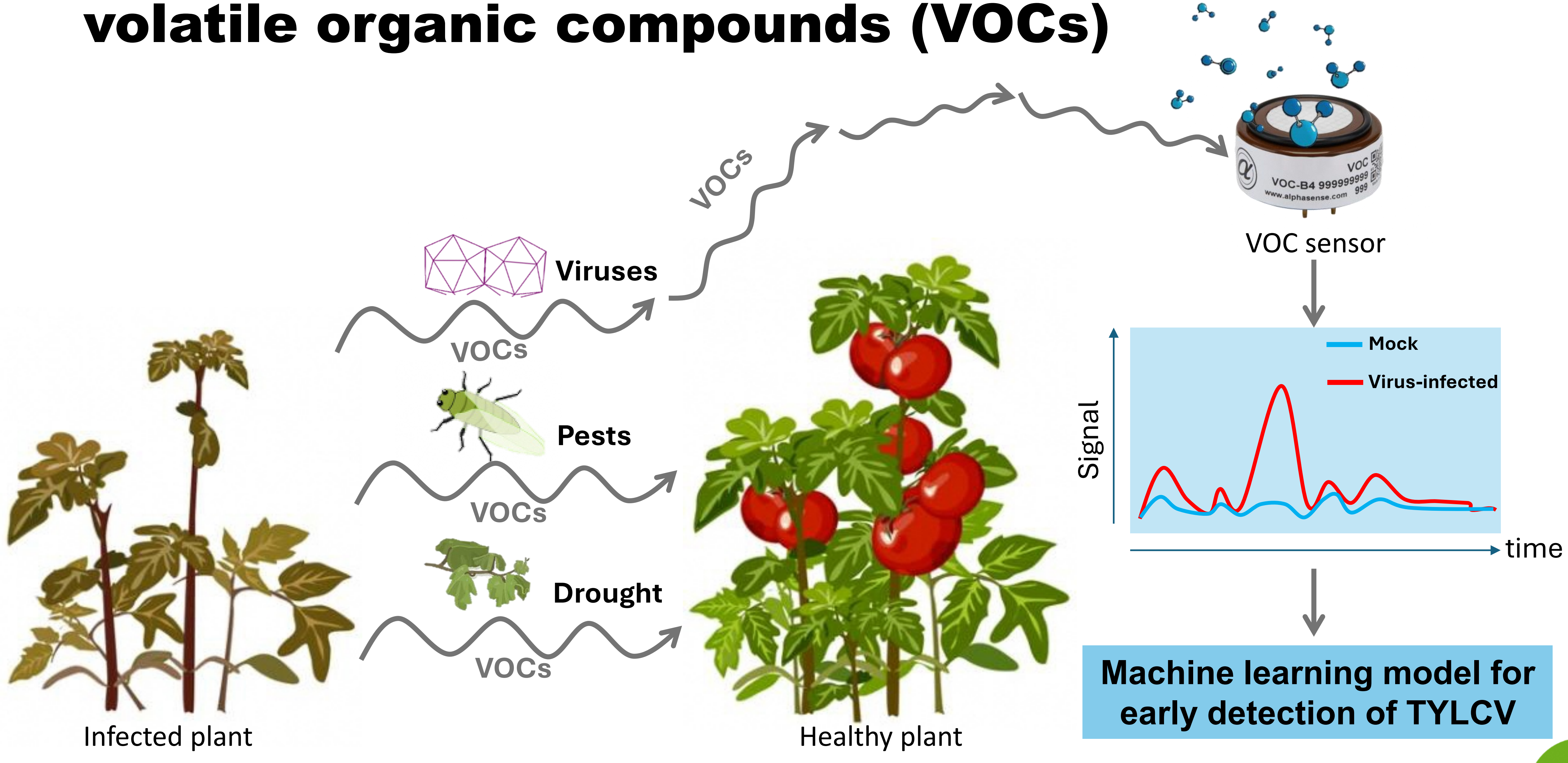


- ✓ Early disease detection
- ✓ High sensitivity and specificity
- ✓ Visual results interpretation
- ✗ Invasive detection
- ✗ Sampling required for detection
- ✗ Costly for a single test
- ✗ Non-scalable monitoring
- ✗ Non-real-time results

VOCs Electronic Nose

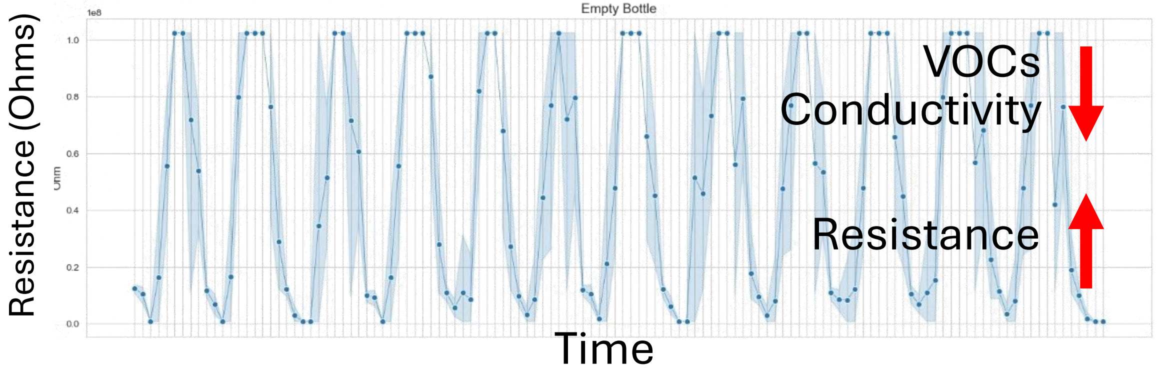
- ✓ Early disease detection
- ✓ Non-invasive monitoring
- ✓ Contactless monitoring
- ✓ Small and portable device (98x98x62 mm, 280 g)
- ✓ Scalable monitoring solution
- ✓ Real-time and rapid response
- ✓ Customizable alerts on mobile devices
- ✗ Expertise required for building model

Plants communicate using volatile organic compounds (VOCs)



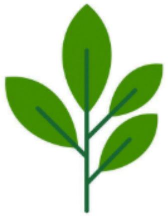
Testing VOC sensor’s ability for different scents

VOCs

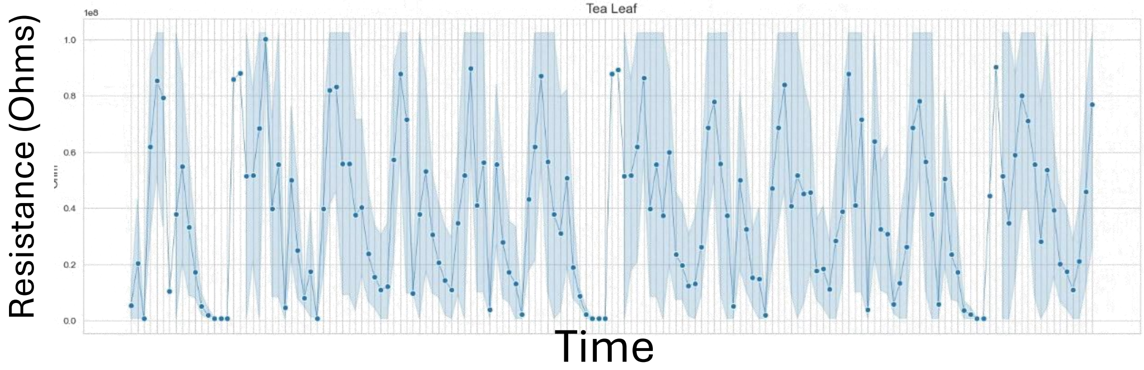


Air

Almost free movement of resistance from zero to one

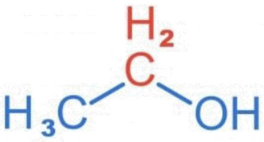


VOCs

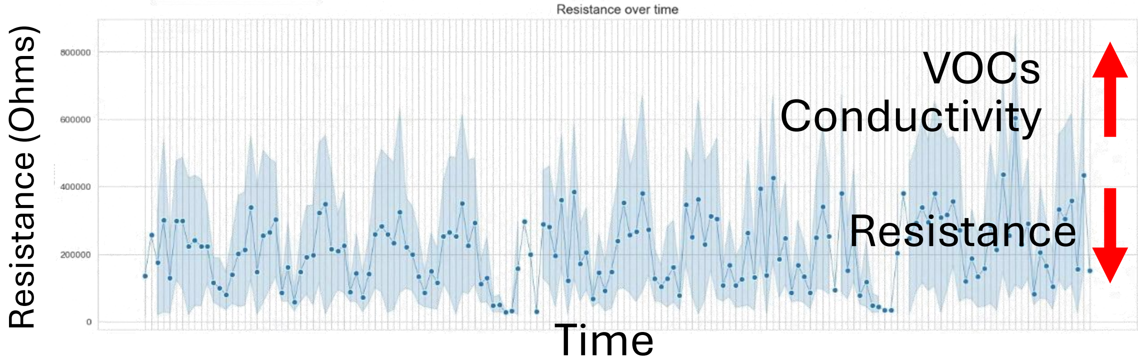


Tea Leaf

Light tea scent cause slight reduced resistance.



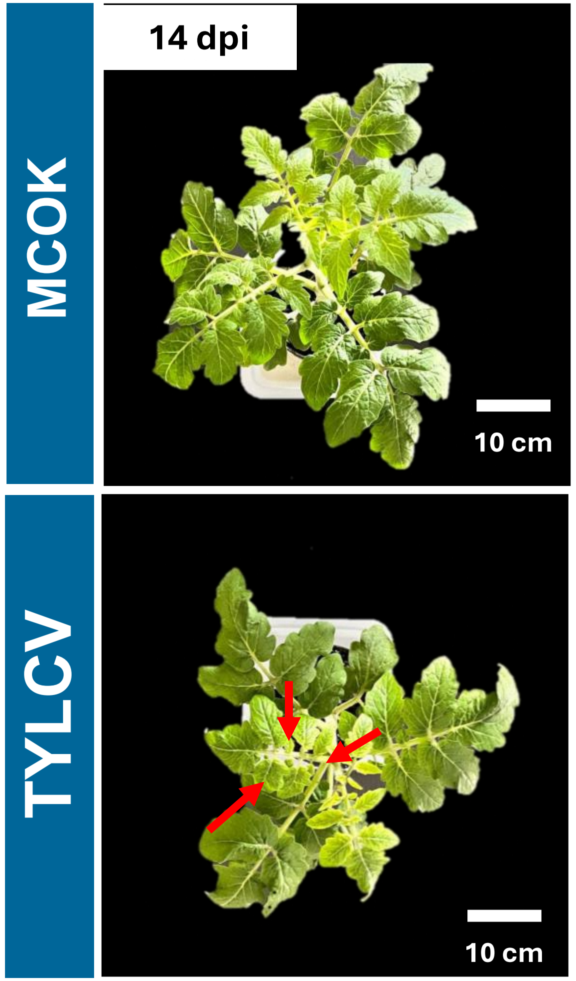
VOCs

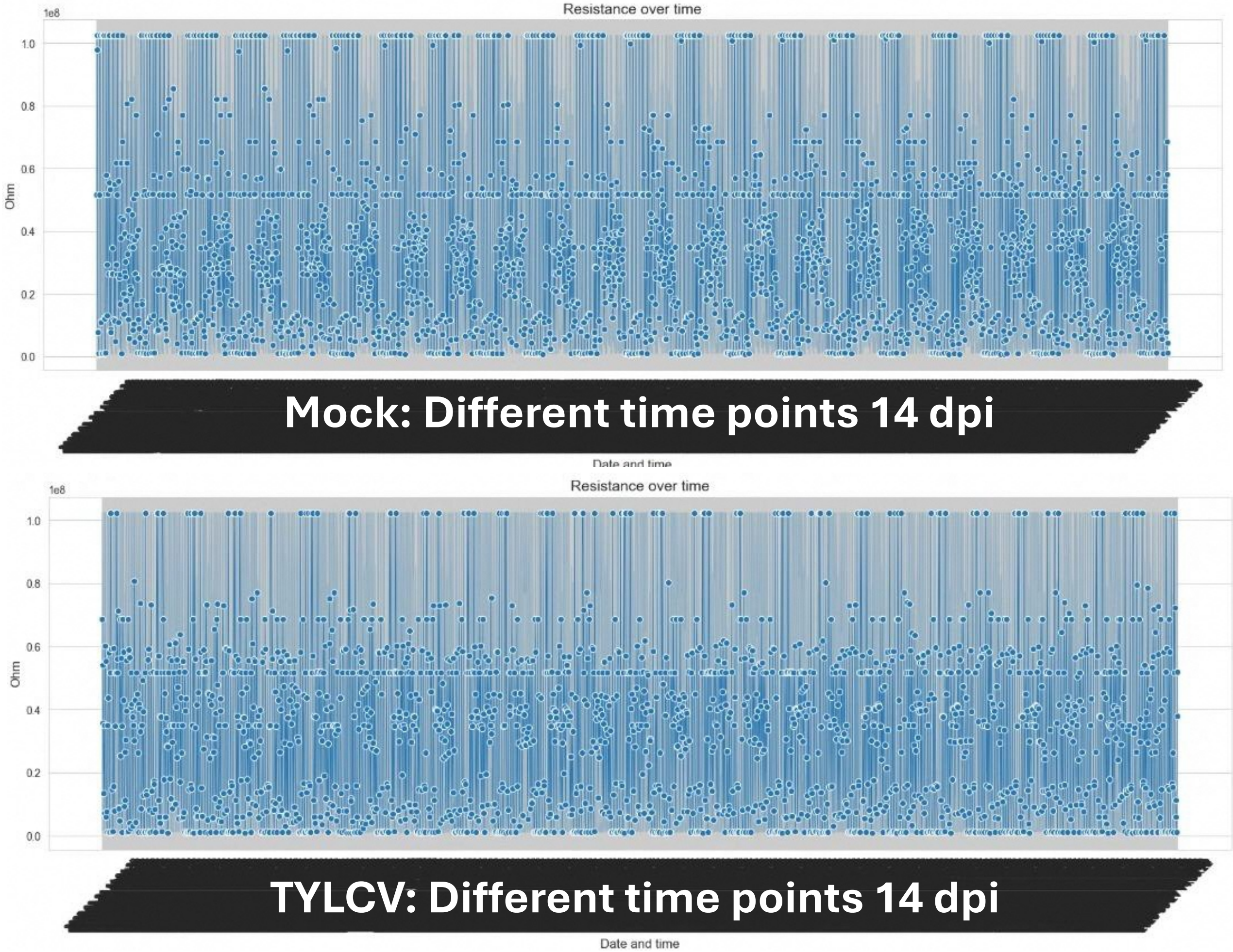


Ethanol

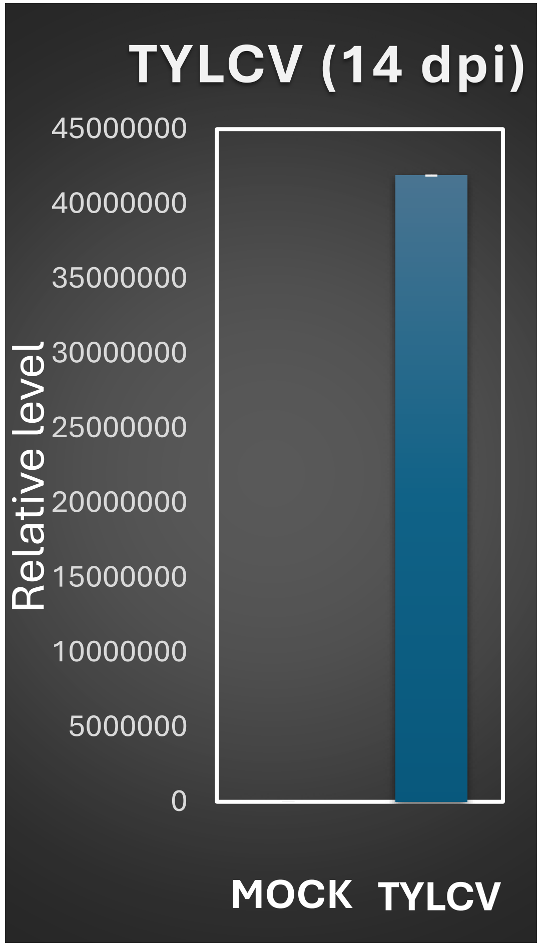
Stronger volatility of ethanol cause strong reduction of resistance.

Testing VOC sensor for TYLCV-induced VOCs





TYLCV-infected tomato showed reduced resistance on VOC sensor

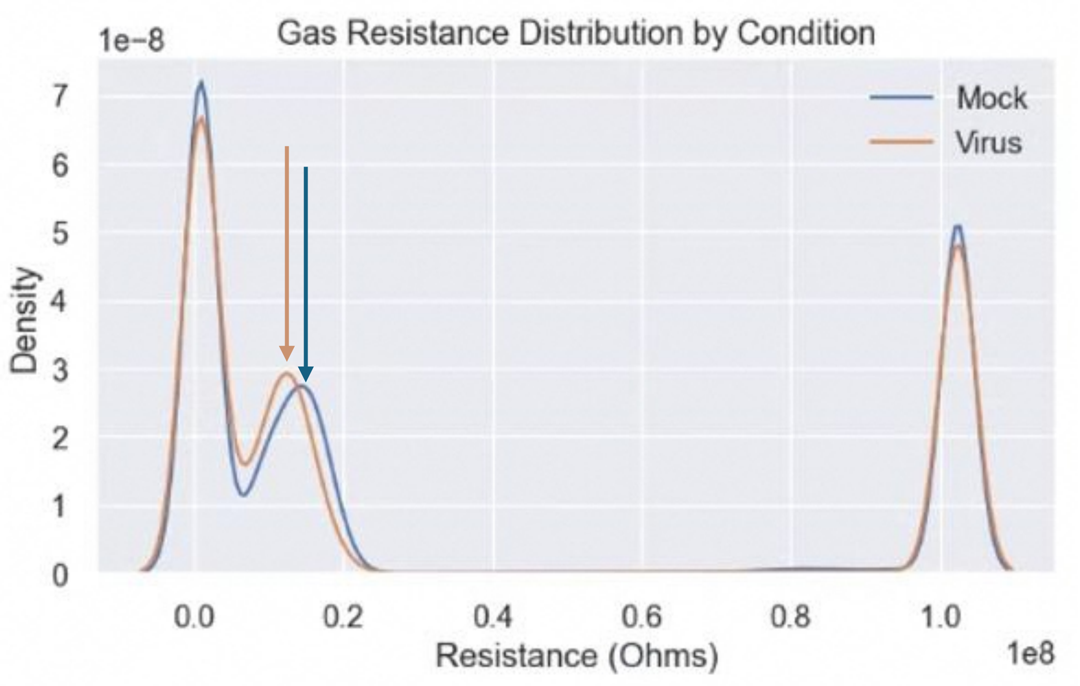


TYLCV infection verified via molecular method

Testing VOC sensor for TYLCV-induced VOCs

Overall distribution pattern

- Both mock-treated and virus-infected plants show a similar VOC distribution profile.
- Indicates that **majority of VOCs remain unchanged** between healthy and infected plants.



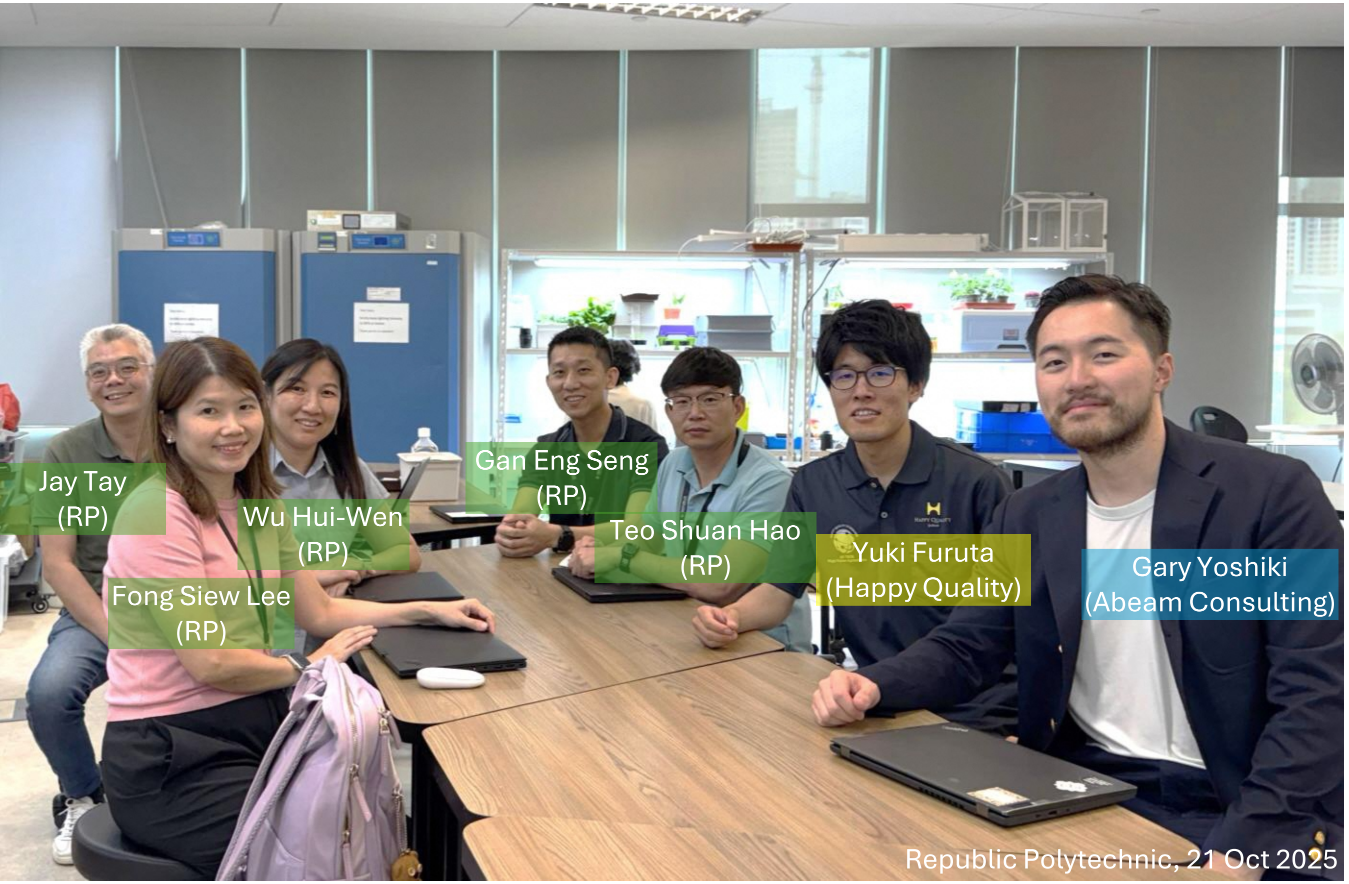
Observed variations

- Minor differences observed in specific VOC regions.
- These variations are likely due to **TYLCV-induced metabolic changes**.

Next step

- Apply **machine learning and advanced algorithms** to **enhance sensitivity** and **amplify subtle VOC differences** for improved detection accuracy.

Timeline of events



Nov 2023

- Networking session with Happy Quality (HQ) during SSAFF4.
- Identified TYLCV as a key issue faced by farmers.
- Early detection highlighted as an area of strong interest.

Feb 2024

- Met with HQ during their visit to Republic Polytechnic (RP) and Tomato Town, a farm in Singapore that is partnering HQ in technology transfer and field application.
- Introduced VOC sensor and highlighted the potential of VOC sensor to detect presence of virus.

Oct 2025

- Discussion with HQ at RP on VOC sensor results for TYLCV detection.
- Next steps for validation, refinement, and potential field deployment.

Thank you