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Novel Tools to Detect Biosecurity Risk

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Background

***Problem*:** The brown marmorated stink bug (BMSB, *Halyomorpha halys*) and *Xylella fastidiosa* are exotic species at the top of Australia's National Priority Plant Pests list. These invasive pests damage over 300 plant species, including important crops such as apples, pears, grapes, olives, avocados, and citrus fruits, leading to yield and quality losses. They present critical biosecurity threats with substantial risks to agriculture and significant economic damage at both national and global levels, affecting regions including America, Italy, Europe, and Asia. Currently, biosecurity detection methods for these pests rely on labor-intensive inspections, trained detector dogs, and expensive, time-consuming laboratory-based techniques such as polymerase chain reaction (PCR) and gas chromatography-mass spectrometry (GC-MS).

***Need*:** These hitchhiker pests should be monitored at both border and field levels. Developing a scalable, portable, and precise point-of-care (POC) detection platform is essential to address the issue mentioned above.

In this work, we aimed to introduce rapid and inexpensive portable electrochemical devices to detect BMSB and *Xylella fastidiosa* based on their unique detection markers- volatile organic compounds (VOC) and distinctive DNA sequences respectively.

Aim & Objective

- Building an electrochemical readout method for the volatile fingerprint of BMSB
- Integrating the electrochemical readout method with other parts of the analysis to create a portable device
- Developing an affordable and rapid DNA isolation method for *Xylella fastidiosa*
- Electrochemical detection of *Xylella fastidiosa* based on interfacial biosensing

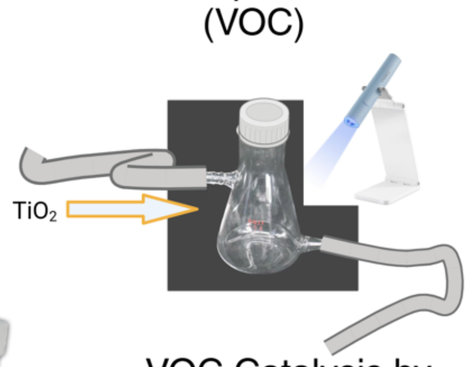
Methods

BMSB Detection

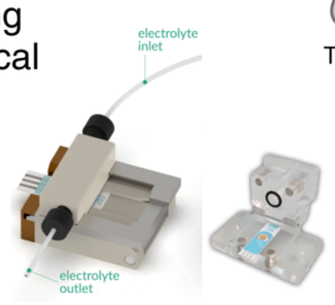
Brown Marmorated stink bug (BMSB)

Target Volatile Organic Compounds (VOC)

Smartphone connected with portable potentiostat and obtaining electrochemical responses



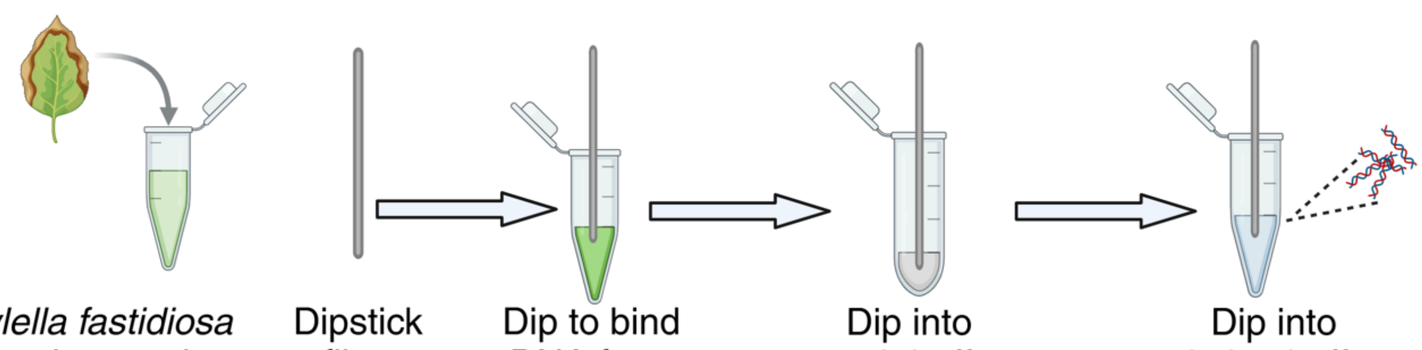
VOC Catalysis by Titanium Dioxide using light source and producing CO_2



CO_2 flow through electrochemical flow cell integrated with SPE

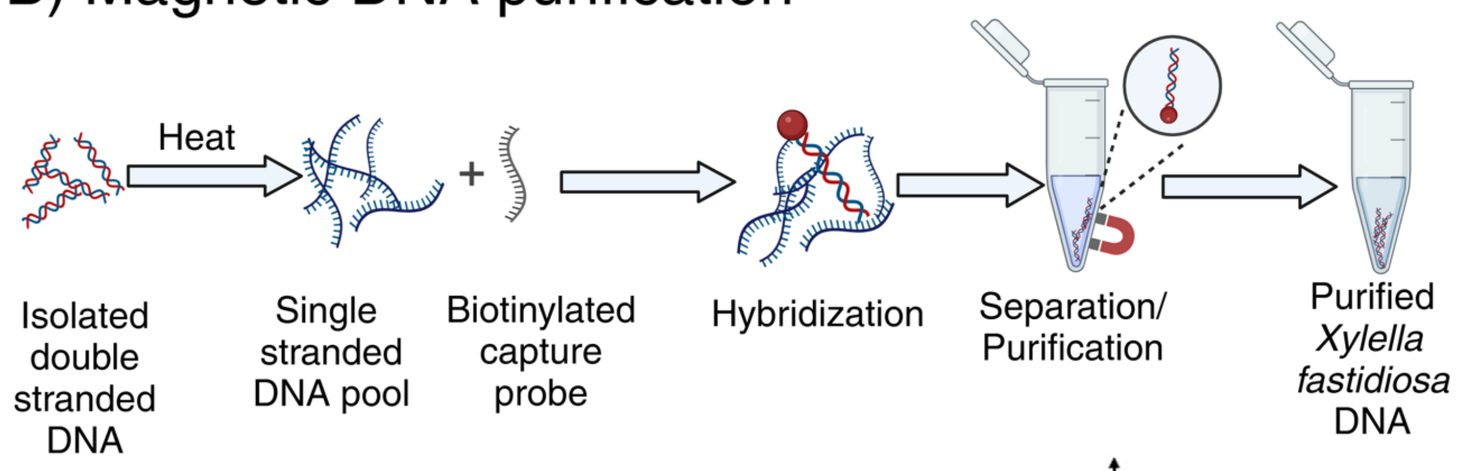
Xylella fastidiosa Detection

A) Rapid dipstick based DNA purification



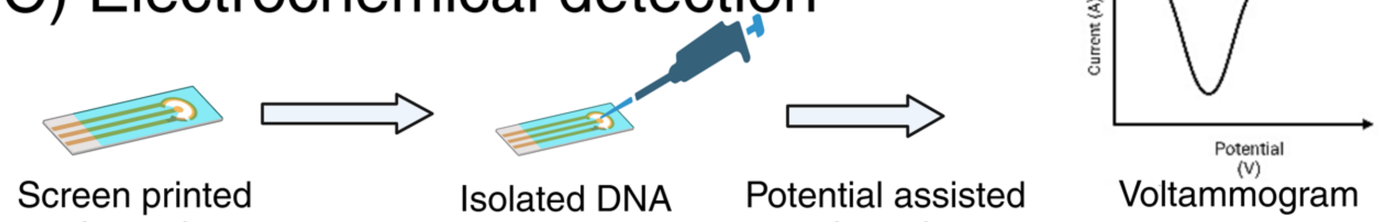
Xylella fastidiosa Crude sample from infected leaf | Dipstick filter | Dip to bind DNA from sample | Dip into wash buffer | Dip into elution buffer to isolate DNA

B) Magnetic DNA purification



Isolated double stranded DNA | Single stranded DNA pool | Biotinylated capture probe | Hybridization | Separation/ Purification | Purified *Xylella fastidiosa* DNA

C) Electrochemical detection



Screen printed electrode (SPE) | Isolated DNA on SPE | Potential assisted adsorption | Voltammogram

Conclusion

These rapid and cost-effective methods will be applicable at the border and even at the field level when needed. In the future, these methods will be applicable for detecting other pests and diseases.

Reference

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