Media Release

SMART Researchers Design Portable Device For Fast Detection of Plant Stress

Raman leaf-clip sensor would allow rapid diagnosis of nutrition deficiency in plants, enabling farmers to maximise crop yield in a sustainable way

- Portable device allows rapid detection of nitrogen deficiency – a critical nutrient for plant health
- When tested on popular vegetables such as Spinach and Kai Lan, the device was also able to detect levels of other metabolites; allowing measurement of a wider range of plant stress phenotypes such as drought, heat/cold, saline and light stress
- New tool offers economical, sustainable, and environmentally-friendly method to fight food insecurity

Singapore, 8 December 2020 - Researchers from the Disruptive & Sustainable Technologies for Agricultural Precision (DiSTAP) Interdisciplinary Research Group (IRG) of Singapore-MIT Alliance for Research and Technology (SMART), MIT's research enterprise in Singapore and Temasek Life Sciences Laboratory (TLL) have designed a portable optical sensor that can monitor whether a plant is under stress. The device offers farmers and plant scientists a new tool for early diagnosis and real-time monitoring of plant health in field conditions.

Precision agriculture is an important strategy for tackling growing food insecurity through sustainable farming practices, but it requires new technologies for rapid diagnosis of plant stresses before the onset of visible symptoms and subsequent yield loss. SMART's new portable Raman leaf-clip sensor is a useful tool in precision agriculture allowing early diagnosis of nitrogen deficiency in plants, which can be linked to premature leaf deterioration and loss of yield.

In a paper titled "Portable Raman leaf-clip sensor for rapid detection of plant stress" published in the prestigious journal *Scientific Reports*, SMART DiSTAP and TLL scientists explain how they designed, constructed, and tested the leaf clip that allows the optical sensor to probe the leaf chemistry and establish the stress state.

"Our findings showed that in vivo measurements using the portable leaf-clip Raman sensor under full-light growth conditions were consistent with measurements obtained with a benchtop Raman spectrometer on leaf-sections under laboratory conditions," says MIT Professor Rajeev Ram, co-Lead author of the paper and Principal Investigator at DiSTAP. "We demonstrated that early diagnosis of nitrogen deficiency – a critical nutrient and the most important component of fertilizers – in living plants is possible with the portable sensor."

While the study mainly looked at measuring nitrogen levels in plants, the device can also be used to detect levels of other plant stress phenotypes such as drought, heat and cold stress, saline stress, and light stress. The wide range of plant stressors that can be detected by these leaf-clip Raman probes and their simplicity and speed makes them ideal for field use by farmers to ensure crop health.

Portable leaf-clip Raman sensor being used at TLL to detect nutrient stress in leafy vegetables. Photo Credit: Singapore-MIT Alliance for Research and Technology (SMART)

“While we have focused on the early and specific diagnosis of nitrogen deficiency using the leaf-clip sensor, we were able to measure peaks from other metabolites that are also clearly observed in popular vegetables such as Kailan, Lettuce, Choy Sum, Pak Choi, and Spinach,” says Dr. Chung Hao Huang, co-first author of the paper and Postdoctoral Fellow at TLL.

The team believes their findings can aid farmers to maximise crop yield, while ensuring minimal negative impacts on the environment, including minimising pollution of aquatic ecosystems by reducing nitrogen runoff and infiltration into the water table.

“The sensor was demonstrated on multiple vegetable varieties and supports the effort to produce nutritious, low-cost vegetables as part of the Singapore 30 by 30 initiative,” says Professor Nam-Hai Chua, co-Lead Principal Investigator at DiSTAP, Deputy Chairman at TLL and co-Lead author of the study. “Extension of this work to a wider variety of crops may contribute globally to improved crop yields, greater climate resiliency, and mitigation of environmental pollution through reduced fertilizer use."

The portable Raman system was designed in collaboration with local company Technospex Pte Ltd. The leaf-clip Raman sensor consists of a 3D printed clip that is built around a fiber-based Raman probe assembly.

Dr. Shilpi Gupta, Postdoctoral Associate at DiSTAP, was co-first author of the paper and Dr. Gajendra Pratap Singh, Scientific Director at DiSTAP, also co-authored the article.

The research was carried out by SMART and supported by the National Research Foundation (NRF) Singapore under its Campus for Research Excellence And Technological Enterprise (CREATE) programme.

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About SMART Disruptive & Sustainable Technologies for Agricultural Precision (DiSTAP) [精准农业技术研究中心]

DiSTAP is one of the five Interdisciplinary Research Groups (IRGs) of the Singapore-MIT Alliance for Research and Technology (SMART). The DiSTAP programme addresses deep problems in food production in Singapore and the world by developing a suite of impactful and novel analytical, genetic and biosynthetic technologies. The goal is to fundamentally change how plant biosynthetic pathways are discovered, monitored, engineered and ultimately translated to meet the global demand for food and nutrients. Scientists from Massachusetts Institute of Technology (MIT), Temasek Life Sciences Laboratory (TLL), Nanyang Technological University (NTU) and National University of Singapore (NUS) are collaboratively: developing new tools for the continuous measurement of important plant metabolites and hormones for novel discovery, deeper understanding and control of plant biosynthetic pathways in ways not yet possible, especially in the context of green leafy vegetables; leveraging these new techniques to engineer plants with highly desirable properties for global food security, including high yield density production, drought and pathogen resistance and biosynthesis of high-value commercial products; developing tools for producing hydrophobic food components in industry-relevant microbes; developing novel microbial and enzymatic technologies to produce volatile organic compounds that can protect and/or promote growth of leafy vegetables; and applying these technologies to improve urban farming.

The DiSTAP IRG at SMART is led by MIT co-lead Principal Investigator Professor Michael Strano and Singapore co-lead Principal Investigator Professor Chua Nam Hai.

For more information, please log on to: http://distap.mit.edu/

About Singapore-MIT Alliance for Research and Technology (SMART) [新加坡-麻省理工学院科研中心]

Singapore-MIT Alliance for Research and Technology (SMART) is MIT's Research Enterprise in Singapore, established by the Massachusetts Institute of Technology (MIT) in partnership with the National Research Foundation of Singapore (NRF) since 2007. SMART is the first entity in the Campus for Research Excellence and Technological Enterprise (CREATE) developed by NRF. SMART serves as an intellectual and innovation hub for research interactions between MIT and Singapore. Cutting-edge research projects in areas of interest to both Singapore and MIT are undertaken at SMART. SMART currently comprises an Innovation Centre and five Interdisciplinary Research Groups (IRGs): Antimicrobial Resistance (AMR), Critical Analytics for Manufacturing Personalized-Medicine (CAMP), Disruptive & Sustainable Technologies for Agricultural Precision (DiSTAP), Future Urban Mobility (FM) and Low Energy Electronic Systems (LEES).

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