Singapore unlocks plant growth secrets with breakthrough universal nanosensors

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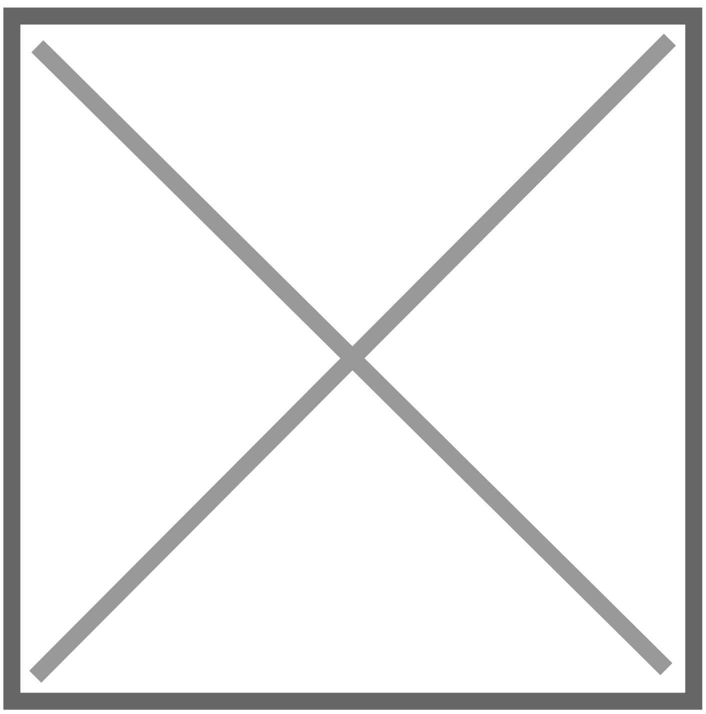

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Singapore researchers from theÂ **Disruptive & Sustainable Technologies for Agricultural Precision (DiSTAP)** Â interdisciplinary research group (IRG) ofÂ Singapore-MIT Alliance for Research and Technology (SMART), MITâ??s research enterprise in Singapore, in collaboration with Temasek Life Sciences Laboratory (TLL) and Massachusetts Institute of Technology (MIT), have developed the worldâ??s first near-infrared (NIR) fluorescent nanosensor capable of real-time, non-destructive and species-agnostic detection of indole-3-acetic acid (IAA) â?? the primary bioactive auxin hormone that controls the way plants develop, grow and respond to stress.

Auxins, particularly IAA, play a central role in regulating key plant processes such as cell division, elongation, root and shoot development, and response to environmental cues like light, heat and drought. External factors like light affect how auxin moves within the plant, temperature influences how much is produced, and a lack of water can disrupt hormone balance. When plants cannot effectively regulate auxins, they may not grow well, adapt to changing conditions or produce as much food.

Existing IAA detection methods, such as liquid chromatography, require taking plant samples from the plant â?? which harms or removes part of it. Conventional methods also measure the effects of IAA rather than detecting it directly, and cannot be used universally across different plant types. In addition, since IAA are small molecules that cannot be easily tracked in real-time, biosensors that contain fluorescent proteins need to be inserted into the plantâ??s genome to measure auxin, making it emit a fluorescent signal for live imaging.

SMARTâ??s newly developed nanosensor enables direct, real-time tracking of auxin levels in living plants with high precision. The sensor uses NIR imaging to monitor IAA fluctuations non-invasively across tissues like leaves, roots and cotyledons, and it is capable of bypassing chlorophyll interference to ensure highly reliable readings even in densely pigmented tissues. The technology does not require genetic modification and can be integrated with existing agricultural systems â?? offering a scalable precision tool to advance both crop optimisation and fundamental plant physiology research.

By providing real-time, precise measurements of auxin â?? a hormone central to plant growth and stress response â?? the sensor empowers farmers with earlier and more accurate insights into plant health. With these insights and comprehensive data, farmers can make smarter, data-driven decisions on irrigation, nutrient delivery and pruning, tailored to the plantâ??s actual needs â?? ultimately improving crop growth, boosting stress resilience and increasing yields.

â??We need new technologies to address the problems of food insecurity and climate change worldwide. Auxin is a central growth signal within living plants, and this work gives us a way to tap it to give new information to farmers and researchers. The applications are many, including early detection of plant stress, allowing for timely interventions to safeguard crops. For urban and indoor farms, where light, water and nutrients are already tightly controlled, this sensor can be a valuable tool in fine-tuning growth conditions with even greater precision to optimise yield and sustainability,â?• saidÂ Prof Michael Strano, Co-Lead Principal Investigator at DiSTAP and Carbon P. Dubbs Professor of Chemical Engineering at MIT, and co-corresponding author of the paper.