DETECTING AND DISTINGUISHING GIBBERELLIN PLANT HORMONES VIA NOVEL NANOTUBE SENSORS

SMART Singapore-MIT Alliance for Research and Technology

Gibberellins (GAs) are a class of phytohormone produced by plants that play an important role in modulating diverse processes involved in plant growth and development. A new type of nanosensor developed by researchers at SMART DiSTAP allows for the study of GA dynamics in living plants under salinity stress at a very early stage, potentially enabling farmers to make early interventions when eventually applied in the field.

Current methods to detect GA_3 and GA_4 typically require mass spectroscopy (MS)-based analysis, a time-consuming and destructive process. In contrast, the new sensors are highly selective for the respective GAs and offer real-time, *in vivo* monitoring of changes in GA levels across a broad range of plant species.

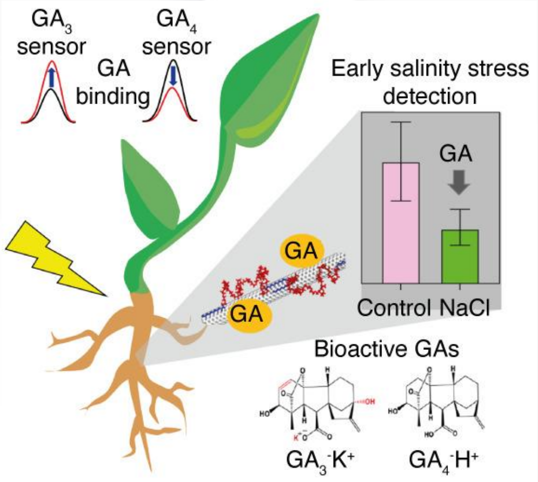
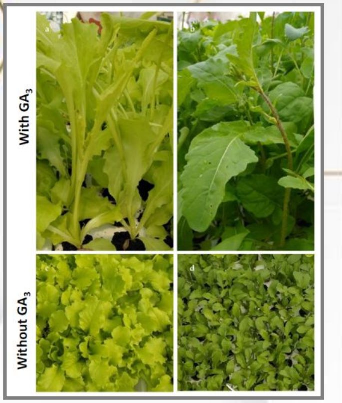


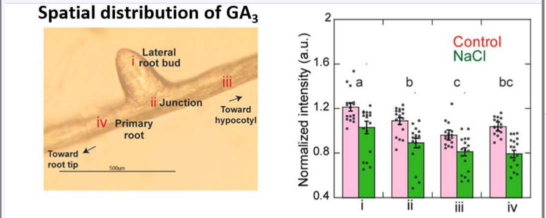
Illustration of GA detection in living plants using near-infrared fluorescent carbon nanotube sensors for early indication of salinity stress

BACKGROUND

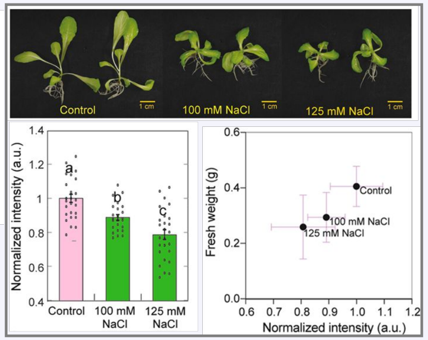
Effect of GA supplementation on hydroponically-grown lettuce (left) and rocket (right). Two weeks treatment with (top) or without (bottom) 100 µM GA_3.



RESULTS

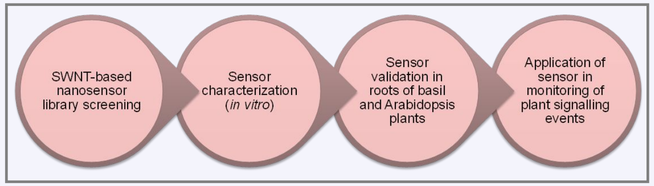


Lateral root emergence requires GA signalling: GA_3 sensor reports higher GA levels at the lateral root bud (i) and at the junction between the primary root and lateral root bud (ii), compared to other areas of primary roots (iii and iv). 100 mM salt stress treatment resulted in approximately 1.2-fold uniform decrease in GA_3 in all locations of the root

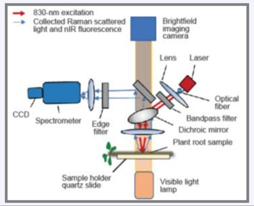


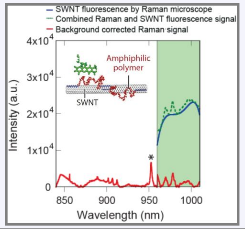
A much earlier indicator of salinity stress: GA_3 sensor reports reduction in fluorescence indicative of decreased GA levels at 6 h of salt treatment (100 mM and 125 mM) while plant morphological data demonstrate stunted lettuce growth only after 10 days of salt treatment.

METHODOLOGY



Reference-free GA measurements in living plants: New coupled Raman/NIR fluorimeter (left) that captures the combined Raman and SWNT NIR fluorescence signal (right) of the GA nanosensors, enabling normalization of nanosensor NIR fluorescence with its Raman G-band (indicated as asterisk).





CONCLUSION

By designing and engineering polymer-wrapped single-walled carbon nanotubes (SWNTs) with unique corona phases that selectively bind to bioactive GAs, GA_3 and GA_4, researchers can detect them through measuring near-infrared (NIR) fluorescence intensity changes.

Using a new coupled Raman/NIR fluorimeter that enables self-referencing of nanosensor NIR fluorescence with its Raman G-band, the research demonstrated detection of cellular GA in *Arabidopsis*, lettuce, and basil roots. This approach allows rapid spatiotemporal detection of GA across species and demonstrates the potential for nanosensors to solve longstanding problems in plant biotechnology.

In collaboration with: TEMASEK LIFESCIENCES LABORATORY; Massachusetts Institute of Technology