Silk microneedle-based drug delivery technique for plants

The silk microneedle-based drug delivery technique developed by SMART researchers can be used to precisely deliver controlled amounts of agrochemicals to specific plant tissues. The novel technique is minimally invasive and is a sustainable and precise practice which will contribute to the sustainability of agriculture and food security.

Current practices for agrochemical application in plants, such as foliar spray, are inefficient due to off-target application, quick run-off in the rain, and actives' rapid degradation. These practices also cause significant detrimental environmental side effects, such as water and soil contamination, biodiversity loss and degraded ecosystems; and public health concerns, such as respiratory problems, chemical exposure and food contamination.

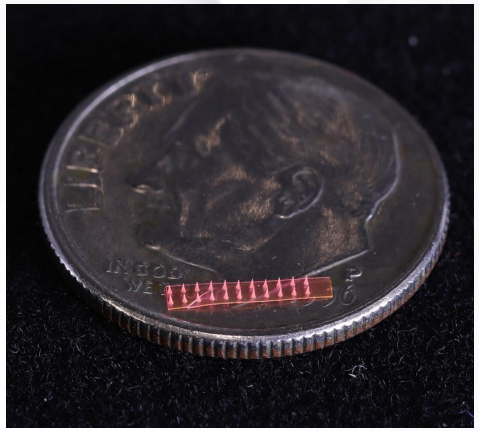

Illustration of a silk microneedle array on a dime coin

BACKGROUND

Why is this important?

Increasing environmental conditions caused by climate change, an ever-growing human population, scarcity of arable land, and limited resources are pressuring the agriculture industry to adopt more sustainable and precise practices that foster more efficient use of resources (e.g. water, fertilisers, and pesticides) and mitigation of environmental impacts.

RESULTS

Illustration of soybean seedlings 6 days post-injection. The plant injected by GA3-loaded silk microneedles showed improved growth in comparison with the soybean seedling with non-treated control

METHODOLOGY

The research studies the first-ever polymeric microneedles used to deliver small compounds to a wide variety of plants and the plant response to biomaterial injection. The study was initially carried out on Arabidopsis (mouse-ear cress), the chosen model plant. Gibberellic acid (GA3), a widely used plant growth regulator in agriculture, was selected for the delivery.

The researchers then confirmed the effectiveness using genetic methods and demonstrated that the technique is applicable to various plant species.

CONCLUSION

By utilising the silk microneedles approach, agrochemical compounds can be delivered directly into plants by penetrating tissue barriers, resulting in precise control over the quantity of agrochemicals applied. This technique enables high-tech precision agriculture, which optimises crop growth and yield.

Furthermore, the research provides a foundation for studying how plants respond to biomaterials using genetic tools. By analysing these responses at a genetic level, researchers can gain an in-depth understanding of those responses, which can serve as a blueprint for the development of future biomaterials for the Agrifood sector.

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