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Organic Antioxidant Nanoparticles to Prevent Intraluminal Callose Formation in the Vasculature of Plants

Antioxidant nanoparticles suppress hypersensitive response in plants, blocking callose formation and protecting vascular function for healthier crop yields.

Researchers at Purdue have developed a nanoparticle formulation for the treatment of the hypersensitive response (HR) in plants, for the purpose of reducing callose formation in plant vasculature to improve the health and output for HR-activated crops. In plants, when pathogen-associated molecules are recognized, the plant may defend itself by activating the HR and forming dense, complex polysaccharides called callose, which can "wall off" infected plant tissue, increasing a plant's survivability. However, the HR defense can in some cases lead to a plant's death if the phloem of a plant (its vasculature) is targeted by viruses/bacteria. This will cause the plant to form a callose within its vasculature, blocking nutrient and water flow throughout the plant.

The researchers developed an antioxidant-loaded nanoparticle that, upon application, will prevent the HR from manifesting within a plant, arresting the formation of calloses within its vasculature. This enables the on-demand prevention/suppression of the HR response in crops, allowing farmers to further manage the health and productivity of their fields.

Technology Validation:

To verify the ability of the nanoparticles to suppress the HR, 60 uL of the nanoparticle formulation was administered to the second true branch of a 28-day-old tomato plant. Following this, the tomato plant was administered flagellin 22 (FLG22), a known HR-modulator, and let to rest for 48 hours. Following this, the stems, roots, and branches exposed to FLG22 were harvested and stained with aniline blue to visualize possible calloses. Upon close investigation with a confocal laser scanning microscope, no aniline blue was visible, indicating little to no formation of calloses. Additionally, the penetration of nanoparticles inside the plant's cells was confirmed by the

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fluorescence signal from the fluorophore being readily visible within the plant cells.

Advantages:

- Significantly reduces hypersensitive response

- Blocks callose formation

- Small nanoparticle size

- Little variability in nanoparticle size

Applications:

- Agriculture

- Plant pathogen interaction

- Suppression of the hypersensitive response in plants

TRL: 3

Intellectual Property:

Provisional-Patent, 2024-02-06, United States

Utility Patent, 2025-02-05, United States

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