Reducing Pesticide Use with Nanoparticles

2020-12-18

Researchers at the Adolphe Merkle Institute and the Department of Biology at the University of Fribourg have discovered how certain silica nanoparticles could act as a traceless, degradable, and highly efficient treatment against some plant pathogens.

One of the biggest challenges facing agriculture today is the extensive use of fertilizers and pesticides. With an increasing number of products banned or considered dangerous for human and animal health, the need for substitutes is acute. One approach is to stimulate plants' own immune response to pathogen attacks. Silicic acid, which naturally occurs in soil, is known to provoke such responses in plants, and amorphous silica nanoparticles can release this substance in small amounts.

These nanoparticles, which are also naturally present in many food crops such as cereals, are more common than most people think. They are part of food grade silica (SiO_2), otherwise known as E551 on labels and packaging, and used for decades in a variety of products such as table salt, pills, or protein powders to avoid clumping.

Increased resistance

With this in mind, the Fribourg-based researchers aimed to create an environmentally safe nano-agrochemical for the targeted delivery of silicic acid and to stimulate plant defense. They synthesized silica nanoparticles with similar properties to those found in plants. To test their efficiency, they applied the nanoparticles on Arabidopsis thaliana (thale cress), a widely used plant model, infected with the bacterial pest Pseudomonas syringae, another model organism.

The results showed that their nanoparticles can boost resistance against the bacteria in a dose-dependent manner by stimulating the plant's defense hormone, salicylic acid (which is also the active ingredient in aspirin). The researchers also investigated the interactions of the

nanoparticles with plant leaves. They were able to show that nanoparticle uptake and action occurred exclusively through the leaf pores (stomata) that allow the plants to breathe.

The nanoparticles did not distribute further in the plants, and the particles degrade without leaving a trace in the presence of water, an important consideration for environmental and food safety. Compared to free silicic acid, which is already used in crop protection, the silica nanoparticles caused less stress to the plants and to other soil microorganisms due to the slow release of the silicic acid.

The study, published in the top-ranking journal Nature Nanotechnology, shows that silica nanoparticles could serve as an inexpensive, highly efficient, safe, and sustainable alternative for plant disease protection.

Innovation

Future research could extend the investigations to a broader spectrum of plant pathogens according to the researchers such as other bacteria, insects, or viruses. They emphasize though that before any broad application of nanoparticles as nano-biostimulants and -fertilizers, a thorough analysis is needed to assess the potential long-term fate of silica nanoparticles in the environment.

The study, a collaboration led by AMI BioNanomaterials Ambizione grant recipient Dr. Fabienne Schwab and the Department of Biology's postdoctoral researcher Dr. Mohamed El-Shetehy, was preceded by a first application project. Schwab developed a patented degradable nanoparticle for the targeted delivery of active ingredients and to stimulate plant resistance.

Starting this year, with support from Innosuisse, the Swiss Innovation Agency, Schwab and her partners at the University of Applied Sciences and Arts Western Switzerland – Fribourg and the Bern University of Applied Sciences' School of Agricultural, Forest and Food Sciences have been performing field trials and upscaling the production of the nanoparticles.

Read the original article on University of Fribourg.