Green leaf volatiles may work as a less toxic pesticide for farmers

January 29 2024, by Sasimonthakan Tanarsuwongkul

Green leaf volatiles are a plant's rapid response to threats. Credit: Star61/Wikimedia Commons, CC BY-SA

Have you ever wondered about that sharp, green note that hits your nose when you mow the lawn or cut flower stems? Those are green leaf volatiles, or GLVs: easily evaporated oils that plants use to communicate with other plants and defend themselves against herbivores or pathogens like bacteria or fungi.

Almost every green plant can quickly synthesize and release GLVs when attacked, both directly warding off attackers as well as indirectly attracting predators of herbivores like insects and priming the plant's other defense mechanisms. Researchers know that GLVs play an important role in protecting plants, but how they work remains unclear.

I am a biochemistry researcher, and through a collaboration between the Wang Lab and Stratmann Lab of the University of South Carolina, my colleagues and I study how plant cells deploy green leaf volatiles. In our recently published research in *Plant, Cell & Environment*, we identified the potential signaling pathways GLVs use to induce defense responses in tomato cells. Our ultimate goal is to figure out ways to use GLVs to control agricultural pests for cleaner farming.

Defense systems in plants

Plants employ many defense systems to protect themselves. The first line of defense involves detecting microbial invaders and the presence of damage using damage-associated molecular patterns, or DAMPs, which are molecules released by damaged or dying cells.

When a cell identifies a DAMP, it triggers an immune response and promotes repair mechanisms. It also leads to changes in calcium ion concentration, further activating immune-related genes and proteins. DAMPs also turn on proteins common in many stress-signaling pathways that activate other defense responses.

Many studies have shown that the effects of GLVs are similar to DAMPs. Therefore, my team and I wanted to prove whether GLVs may also act as DAMPs.

To do this, we studied which proteins are turned on or off in tomato cells. Chemically changing the structure of a protein through a process

called phosphorylation turns it on or off. Protein phosphorylation plays a central role in regulating a great number of cellular processes and involves many signal transmission pathways. Studying the phosphoproteome, or all the proteins that are phosphorylated in one system, of tomato cells could help us compare the signaling pathways of GLVs and DAMPs.

We found that many of the proteins involved in green leaf volatile signaling pathways were involved in regulating stress. These included many components of DAMP signaling pathways, supporting our hypothesis that GLVs function like DAMPs in activating defense responses.

Using GLVs in agriculture

Agriculture often places significant pressure on natural resources and the environment. For example, the use of conventional pesticides can lead to environmental degradation and pest resistance.

Biopesticides are rising in popularity as a less toxic alternative. These are naturally occurring organisms or compounds that suppress the growth and spread of pests. For example, volatile organic compounds from plants are a type of biopesticide that have been proven to allow for reduced use of synthetic insecticides to manage pests in stored food grains.

Therefore, GLVs may also be effective biopesticides in farming. One study has shown that GLVs can attract a plant pest, the Apion miniatum beetle, to feed on an invasive and difficult to control weed, Rumex confertus. In addition, field studies on wild tobacco plants found that releasing GLVs can attract enemies of herbivores. The presence of these herbivore competitors can not only control insect pests but also increase the production of infested plants.

With further research, we believe GLVs have the potential to naturally control pests and support sustainable agriculture.

More information: Sasimonthakan Tanarsuwongkul et al, Green leaf volatiles co-opt proteins involved in molecular pattern signalling in plant cells, *Plant, Cell & Environment* (2024). DOI: 10.1111/pce.14795

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