Infested tomatoes provide defensive weapons for healthy neighbors

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The Tomato, (Lycopersicon lycopersicum) flowering, associated with a young, developing fruit. Credit: Earth100/Wikipedia

(Phys.org) —Plants have chemical defenses against infestation. Sometimes, infested plants release volatile chemicals that signal other, non-infested plants to build up defenses of their own. Koichi Sugimoto and his colleagues at Yamaguchi University in Japan studied this plant-plant signaling system in tomatoes. They found that tomato plants infested with cutworms release a volatile chemical that healthy, neighboring plants use to create a pesticide. The research appears in the *Proceedings of the National Academy of Sciences*.

Sugimoto and his colleagues wanted to understand how non-infested plants receive signals from infested ones, and how the non-infested plants use those signals. They studied tomatoes infested with cutworms, larvae of the Spodoptera litura moth.

The researchers placed two tomato plants in connected chambers, exposing the downwind plant to volatiles produced by the upwind plant. They then infected the upwind plant with cutworms. As a control, they placed two more uninfected tomato plants in another set of connected chambers.

Later, the team exposed both downwind plants to cutworms.The survival rate of cutworms on the plant downwind of the infested plant was significantly lower than the survival rate of cutworms on the control plant. When the researchers analyzed leaf extracts from both downwind plants, they discovered that the plant downwind of the infested plant had much higher levels of the chemical HexVic, or (Z)-3-hexenyl-vicianoside, than the control plant did. When they fed HexVic to cutworms, the cutworms' survival rate decreased by 17%, a sign that HexVic was acting as a pesticide.

(Z)-3-hexenol, a chemical used to make HexVic, was a major component of the volatiles produced by the infested plant. Sugimoto's team hypothesized that the healthy plant was using (Z)-3-hexenol released by the infested plant to create its own HexVic. To test this hypothesis, the researchers sprayed tomato plants with radioactive

(Z)-3-hexenol. These plants produced a large amount of radioactive HexVic but no non-radioactive HexVic. The spayed plants had the same levels of endogenous, non-radioactive (Z)-3-hexenol as control plants did. This meant the sprayed plants were using (Z)-3-hexenol from the air, not from their own stores, to create HexVic.

The team then tested their hypothesis outside the laboratory. When they planted tomatoes in a field, they found that healthy plants exposed to volatiles from cutworm-infested plants had higher levels of HexVic than controls.

Many plants can create HexVic, and the researchers believe it may have uses other than defense. To learn more about HexVic's ecological role, they plan to engineer a plant unable to synthesize it.

More information: Intake and transformation to a glycoside of (Z)-3-hexenol from infested neighbors reveals a mode of plant odor reception and defense, Koichi Sugimoto, *PNAS*, DOI: 10.1073/pnas.1320660111

Abstract
Plants receive volatile compounds emitted by neighboring plants that are infested by herbivores, and consequently the receiver plants begin to defend against forthcoming herbivory. However, to date, how plants receive volatiles and, consequently, how they fortify their defenses, is largely unknown. In this study, we found that undamaged tomato plants exposed to volatiles emitted by conspecifics infested with common cutworms (exposed plants) became more defensive against the larvae than those exposed to volatiles from uninfested conspecifics (control plants) in a constant airflow system under laboratory conditions. Comprehensive metabolite analyses showed that only the amount of (Z)-3-hexenylvicianoside (HexVic) was higher in exposed than control plants. This compound negatively affected the performance of common

cutworms when added to an artificial diet. The aglycon of HexVic, (Z)-3-hexenol, was obtained from neighboring infested plants via the air. The amount of jasmonates (JAs) was not higher in exposed plants, and HexVic biosynthesis was independent of JA signaling. The use of (Z)-3-hexenol from neighboring damaged conspecifics for HexVic biosynthesis in exposed plants was also observed in an experimental field, indicating that (Z)-3-hexenol intake occurred even under fluctuating environmental conditions. Specific use of airborne (Z)-3-hexenol to form HexVic in undamaged tomato plants reveals a previously unidentified mechanism of plant defense.

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