

Plants found to speak roundworm's language

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These tomato roots have been infected with southern root-knot nematodes (*Meloidogyne incognita*). The microscopic roundworms form galls or "knots" where they feed, ultimately stunting the plants and reducing yield. Credit: BTI/Murli Manohar

Nematodes are tiny, ubiquitous roundworms that infect plant roots, causing more than \$100 billion in crop damage worldwide each year. New research has found that plants manipulate the worms' pheromones to repel infestations, providing insights into how farmers could fight these pests.

Led by Boyce Thompson Institute faculty member Frank Schroeder, the group studied a group of chemicals called ascarosides, which the worms produce and secrete to communicate with each other. As described in a paper published in *Nature Communications* on January 10, the researchers have shown that [plants](#) also "talk" to nematodes by metabolizing ascarosides and secreting the metabolites back into the soil.

"It's not only that the plant can 'sense' or 'smell' a [nematode](#)," Schroeder said. "It's that the plant learns a [foreign language](#), and then broadcasts something in that language to spread propaganda that 'this is a bad place'. Plants mess with nematodes' communications system to drive them away."

The study built on the team's previous work showing that plants react to ascr#18—the predominant ascaroside secreted by plant-infecting nematodes—by bolstering their own immune defenses, thereby protecting them against many types of pests and pathogens.

In those earlier studies, "We also saw that when ascr#18 was given to plants, the chemical disappears over time," according to lead author

Murli Manohar, a senior research associate at BTI.

That observation, along with published literature suggesting plants could modify pest metabolites, led the team to hypothesize that "plants and nematodes interact via small molecule signaling and alter one another's messages," Schroeder said.

To probe that idea, the team treated three [plant species](#)—Arabidopsis, wheat and tomato—with ascr#18 and compared compounds found in treated and untreated plants. They identified three ascr#18 metabolites, the most abundant of which was ascr#9.

The researchers also found Arabidopsis and tomato roots secreted the three metabolites into the soil, and that a mixture of 90% ascr#9 and 10% ascr#18 added to the soil steered nematodes away from the plant's roots, thereby reducing infection.

The team hypothesized that nematodes in the soil perceive the mixture as a signal, sent by plants already infected with nematodes, to "go away" and prevent overpopulation of a single plant. Worms may have evolved to hijack plant metabolism to send this signal. Plants, in turn, may have evolved to tamper with the signal to appear as heavily infected as possible, thereby fooling would-be invaders.

"This is a dimension of their relationship that no one has seen before," said Manohar. "And plants may have similar types of chemical communication with other pests."

Although the mixture of ascr#9 and ascr#18 could serve as a crop protectant, Schroeder said there should be no detriment to using straight ascr#18 on crops, as described in the team's earlier research.

"Ascr#18 mainly primes the plant to respond more quickly and strongly

to a pathogen, rather than fully inducing the defensive response itself," he said. "So there should be no cost to the plant in terms of reduced growth, yield or other problems."

The team also showed that plants metabolize ascarosides via the peroxisomal β -oxidation pathway, a system conserved across many plant species.

"This paper uncovers an ancient interaction," Schroeder said. "All nematodes make ascarosides, and plants have had millions of years to learn how to manipulate these molecules."

He added: "Plants aren't passive green things. They are [active participants](#) in an interactive dialog with the surrounding environment, and we will continue to decipher this dialog."

More information: Manohar, M., Tenjo-Castano, F., Chen, S., Zhang, Y.K., Kumari, A., Williamson, V.M., Wang, X., Klessig, D.F. and Schroeder, F.C., 2020. Plant metabolism of nematode pheromones mediates plant-nematode interactions. *Nature Communications*, [DOI: 10.1038/s41467-019-14104-2](https://doi.org/10.1038/s41467-019-14104-2)

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