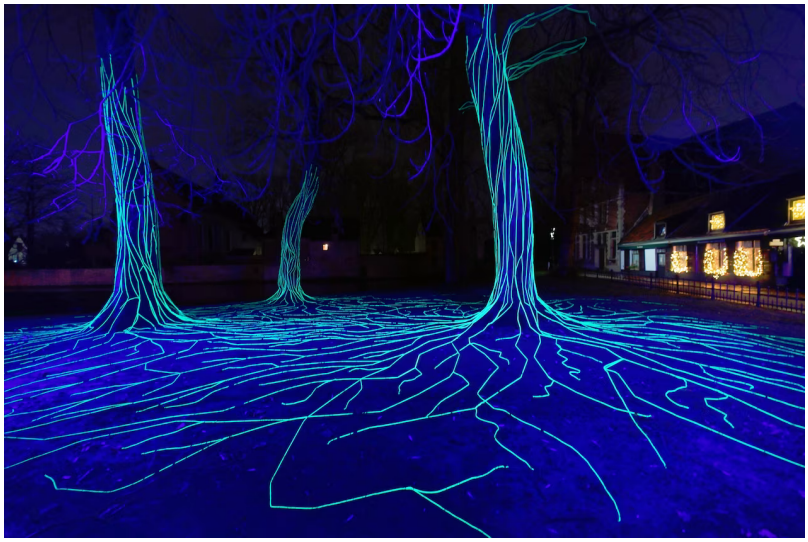

This display in Bruges, Belgium, celebrates networks that connect trees and other plants through fungi underground. It's just one of the ways plants can “talk” to each other and organisms from microbes to animals like us.
PHOTOGRAPH BY SYLVAIN LEFEVRE, GETTY IMAGES

SCIENCE | EXPLAINER

Plants can talk. Yes, really. Here’s how.

Animals aren’t the only ones with the gift of gab. But what are plants actually “saying” to each other? The answer could help feed the world.

BY **ALLIE YANG**

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“Help!” “Land here!” “Conserve resources!” “Get off!” “My fruits are ready to eat!”

These are just some of the many messages we know plants—from a patch of moss to a 300-foot sequoia—can send. In fact, if you’ve ever smelled freshly mowed grass, you’ve communicated with a plant.

“I think we're seeing that the complexity [of communication] is just as great with plants as it is with animals,” says Mamta Rawat, a microbiologist and program director at the National Science Foundation (NSF). “I think there's a lot more to be learned—we’re just touching the tip of the iceberg.”

In March, a new study showed many different plant species make ultrasonic sounds to communicate stress. It’s the latest evidence showing how plants “talk” with everything from predators to pollinators.

This research has an important use. Understanding how plants communicate could help us increase arable lands to feed our growing population and adapt to climate change.

Heard it through the grapevine

To react to their environment, a single plant must communicate among its roots, stems,

leaves, flowers, and fruit.

Instead of signals moving through a nervous system like ours, Simon Gilroy, professor of botany at University of Wisconsin-Madison, says in plants, it's more like plumbing.

Leaves detect predators or changes in light and sound, and roots monitor conditions below ground—problems with nutrients, water, and predators could be there too.

Electrical signals travel through the movement of chemicals in those tubes, explains Courtney Jahn, a biologist and NSF program director who studies plant interactions. For example, roots can detect drought and tell leaves to limit transpiration and conserve water.

(*Can we hack plant DNA to fight climate change*?)

Researchers can observe this electrical communication by placing electrodes in two different places on a plant. We've even made instruments (like this one) that can translate that electric charge into sounds we can hear. If a plant is wounded, electrical signals emanate from that wound, Gilroy says. And plants can transmit these electric signals between individuals if they are touching.

Both venus fly traps and sensitive plants (*Mimosa pudica*) transmit electrical signals when touched, Jahn says. The former closes its mouth to trap their prey, while the sensitive plant moves to shake insects off.

Chemicals, including hormones, also travel within a plant.

A hormone called auxin is produced at the top of a plant and travels downwards—telling a sprout trying to break through the soil's surface which way is up. When there's an urgent threat, like predation from insects, the plant must react quickly or be entirely consumed. Many plants under this kind of stress send out the hormone jasmonic acid, which tells the plant to start producing a toxin to defend itself.

Some species can detect plants responding to

danger (a mouse might “hear” it, an insect might “smell” it), like hearing someone yell “ow!” in the distance. It’s difficult to say whether those signals just happen, or if they are intended for others to receive them.

Shout it from the rooftops

Communicating with their surroundings can help plants survive. Eye-catching flowers blooming in the spring send a message to insects and animals that their flowers are ready for pollination.

(*Chile’s new national park protects nearly 200 flower species and other wonders*.)

Researchers found that with special microphones that detect bat calls, you can hear plants, too. A wide range of species from tomatoes to cacti emit ultrasonic popping sounds when they’re stressed that can be heard by insects like moths, and mammals like bats and mice. Scientists are listening to these sounds of distress to find new methods to diagnose, treat, and monitor plants without touching them.

Mosses (like this one in Omora Ethnobotanical Park in Chile) are one of many kinds of plants that form symbiotic relationships with fungi. Mosses provide sugars they make through photosynthesis, and the fungi give the mosses nutrients.
PHOTOGRAPH BY ALBERTO PEÑA, AFP/GETTY IMAGES

As humans, we may not be able to naturally hear them, but we can often smell plant messages. When grass is cut, it releases gaseous chemicals, a fragrant distress signal. It's a comforting scent

to those of us who associate it with being outside in warmer months. Plants also release this scent when eaten by a caterpillar—and as if responding to their call for help—other bugs take notice and prey on those caterpillars.

(*Can crops grow in the dark*?)

This smelly signal belongs to a group of chemicals called volatiles, which can travel far as gasses both above and below ground. Each plant species has their own special mixture of volatile compounds.

Natalia Dudareva, biochemist at Purdue University, says these volatile compounds have many different functions. Volatiles can draw in pollinators when a flower is ready, and even direct them to flowers left unpollinated. Volatiles from fruits attract organisms that will eat and

distribute seeds. They're also sent from leaves to "intoxicate" and drive away predators (think of how you react when you're next to someone who's wearing too much perfume.)

Researchers have also learned plants can send messages through volatiles about specific threats they're facing, like predation. Plants neighboring a volatile-emitting plant have been observed to prepare to defend against a threat before they experience it themselves.

Plants can also detect kin vs non-kin using volatiles and change their behavior accordingly. For example, plants will detect their offspring and help them grow instead of competing with them for resources, says Andrea Clavijo McCormick, research officer at the school of agriculture and environment at Massey University.

Plants release volatiles underground, too. Especially prevalent in forests, plants send a "come here" signal to fungi underground, which wraps around the root. Many fungi can stretch and gather nutrients, delivering it back to the plant in exchange for sugar the plant made through photosynthesis.

Let's stay in touch

A tree in a forest will form relationships with

many different fungi, and one fungus will have relationships with many different trees—connecting them in a mycorrhizal network ("myco" means fungus, "rhizal" means root), says Cathie Aime, professor of mycology at Purdue University and rotating program director at NSF.

Interesting "conversations" happen where fungus meets root. The two parties have been observed swapping bits of small RNA, which alter gene expression in the other organism. If the fungus is an ally, it says: "you can trust me," and it helps the plant grow. If the fungus is a foe, the small RNA from the fungus turns off the plant's defensive genes, making it easier for the fungus to attack, says Rawat.

When multiple trees are connected by one fungus, they can share resources. Carbon has been traced going through an older "nurse" tree

through fungal networks to another, younger tree that's too young to get a good source of light and photosynthesize.

Below ground, plants also communicate with microbes. Like fungi, they're drawn to the roots and attach themselves by forming a biofilm. For example, growth-promoting bacteria can prime the plant's defenses, increasing their resistance to disease.

Research into plants' microbiome below ground is ripe for exploration, and findings could help us enrich soil to feed our growing population.