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In Brief

Sending out an SOS: Direct plant-to-plant communication mediates network acquired acclimation

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When we find ourselves in danger, we tend to run away and cry for help. Plants are rooted into the ground, so that's it; or is it? In fact, they have developed intricate mechanisms to minimize stress exposure and its negative consequences. When growing in a polluted environment, they can redirect their root growth toward less polluted soil patches. Similarly, morphological alterations enhance leaf cooling when ambient temperatures increase. And although plants do not speak or cry for help, they do warn their neighbors of lurking danger and communicate with each other. Indeed, underground communication can occur between plants through mycorrhizal networks, while the emission of volatile compounds allows plants to send signals aboveground (Karban, 2021). In this issue, **Magdalena Szechyńska-Hebda, Maria Lewandowska, and colleagues** (Szechyńska-Hebda et al., 2022) show that plants can also directly communicate when their leaves touch, thereby mediating network acquired acclimation (see Figure). This newly discovered phenomenon relies on electrical, reactive oxygen species (ROS), and calcium signals, which are also the protagonists in the previously described systemic acquired acclimation (Karpinski et al., 1999; Szechyńska-Hebda et al., 2010; Fichman and Mittler, 2021).

To study direct aboveground plant-to-plant communication, the authors used dandelion (*Taraxacum officinale*) as a model. They showed that heat-induced injury of one dandelion leaf resulted in higher non-photochemical quenching (NPQ) in the immediate surroundings of the injury site. The response then spread to distal leaf areas in a wave-like fashion, indicating systemic signaling. Notably, signal propagation was not restricted to tissues within the same plant, but also extended to leaves of a second dandelion plant when it was connected to the injured plant via a drop of water. The transmission of this rise in NPQ coincided with the propagation of electrical and ROS signals between the leaves of the two plants. When the drop connecting the two plants contained the calcium antagonist lanthanum chloride, injury-induced increases in ROS levels were blocked in both the transmitter and receiver plants, pointing to a role for calcium channels in this signal transduction. The authors hypothesized that electrical signals are the main conduits of this aboveground communication pathway, as they observed responses in receiver plants when plants were connected through a copper wire, which can transmit electrical signals but not ROS.

These injury-induced signals appeared to also be transmitted from a primary receiver to a secondary receiver plant when arranged in a two-chain system, indicating that communication can extend over an entire network of touching plants. Such communication networks likely contribute to stress acclimation, as signals from a heat-injured leaf of a transmitter plant influenced the acclimation responses of receiver plant leaves to subsequent excess light exposure. Importantly, signaling also took place between dandelion and Arabidopsis (*Arabidopsis thaliana*) or Mimosa (*Mimosa pudica*) leaves connected by a copper wire, suggesting that different plant species can communicate through a universal electrical language.

To further investigate the newly identified communication system at the molecular level, the authors switched to

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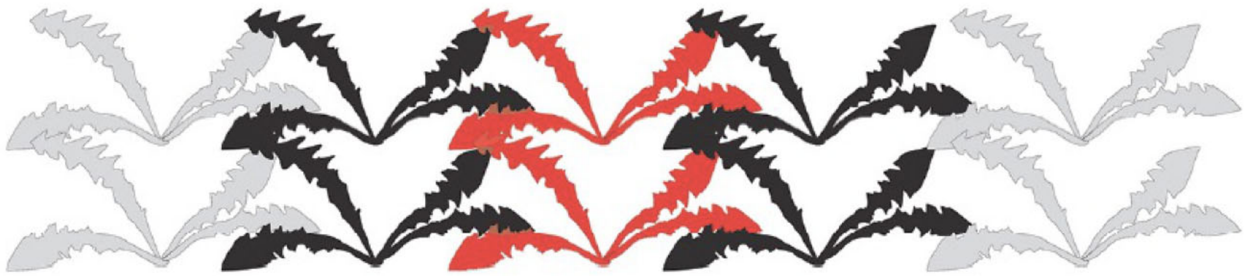

Figure Plant-to-plant communication mediates network acquired acclimation. Electrical, reactive oxygen species, and calcium signals enable communication between leaves of touching plants, if connected through a drop of water. Signals are transduced from injured transmitter plants to primary receiver plants and subsequently to secondary receiver plants arranged in a two-chain system. Reprinted from Szechyńska-Hebda et al. (2022), Figure 5A.

Arabidopsis as a model system. They showed that an injury-induced ROS wave can travel from a transmitter through a mediator plant, ultimately reaching the receiver plant. However, when mutants in key players of ROS, calcium, and electrical signaling were used as mediators, the signal no longer traveled beyond the transmitter plant.

In conclusion, this study revealed that leaves of neighboring plants can directly communicate through a system involving electrical signals, ROS, and photosystem networks. These results offer a new perspective on plant stress signaling and raise several questions, especially concerning the functional significance of network acquired acclimation. As signal transduction only occurred between leaves connected through a drop of water, but not between dry leaves, it is interesting to speculate that this system serves as a complementary pathway to emission of volatile compounds, which is compromised under humid conditions. Moreover, we should wonder whether and how changes in humidity and precipitation brought about by climate change might influence plant communication via these systems.

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