New way to gauge plant drought tolerance

DROUGHT TEST: Scientists at UCLA and in China have developed a method to measure a leaf's drought tolerance that's 30 times faster than the method currently in use.

Key Points

- Drought-tolerant plants have low turgor loss points and saltier sap.
- UCLA has developed a rapid assessment of plant drought tolerance.
- The new method can be applied in 10 minutes to different plant species.

By **STUART WOLPERT**

UNIVERSITY of California, Los Angeles, life scientists, working with colleagues in China, have discovered a new method to assess plants' drought tolerance quickly. The method works for many diverse species growing around the world.

The research, published in the journal *Methods in Ecology and Evolution,* may revolutionize the ability to survey plant species for their ability to withstand drought, says senior author Lawren Sack, a UCLA professor of ecology and evolutionary biology.

"This method can be applied rapidly and reliably for diverse species across ecosystems worldwide," he says.

Droughts, which are a major threat to plants worldwide, are expected to become both more frequent and more severe with climate change, Sack says. Assessing species' vulnerabilities to drought is essential to predict their responses to climate change and plan their conservation, he says.

Faster solution

Earlier this year, Sack and his research team resolved a decades-old debate about what leaf traits best predict drought tolerance for diverse plant species worldwide. However, these leaf traits are too difficult and time-consuming to measure, often taking up to two days for one species, Sack says.

The UCLA team worked with collaborators at the Xishuangbanna Tropical Botanical Gardens, or XTBG, in Yunnan, China, to develop a method for measuring leaf drought tolerance that is 30 times faster. It is based on a trait known as "turgor loss point." During drought, the leaf cells' water becomes harder to replace. The turgor loss point is reached when leaf cells become so dehydrated their walls lack firmness. This cell-level loss of turgor — or swollenness — causes the leaf to become limp and wilted, and the plant cannot grow, Sack says.

The new method, based on "osmometry," requires only about 10 minutes per leaf, sufficient time to make a fast estimate for a given species.

Plant growth depends on the ability to withstand enormous losses of water to evaporation when plants open their pores, or stomata, to take in carbon dioxide for photosynthesis. The amount of evaporation a plant can tolerate depends on the water pressure inside of its cells, which in turn depends on its turgor potential, the pushing force of water against the inside of the cell walls and the osmotic potential inside the cell — which is to say, the pulling force of dissolved salt molecules on the water molecules. This is the same force that makes water with salt added boil at a higher temperature.

Plant cells need to maintain their turgor pressure to hold up their cell walls, but as evaporation dries out the cells, they lose turgor pressure, says co-author Christine Scoffoni, a UCLA graduate student.

Tolerance point

At the turgor loss point, saltier cells have a stronger pulling force holding the water molecules inside the cell. Plants with saltier cells can keep their stomata open in drier conditions, Sack says.

The turgor loss point, which varies among species, is a powerful determinant of the plant's drought tolerance.

"Drought-tolerant plants typically have low turgor loss points and saltier sap," says lead author Megan Bartlett, a UCLA graduate student in the Department of Ecology and Evolutionary Biology. "Some plant species even load more salt into their cells when they experience a drought to lower their turgor loss point and improve their drought tolerance.

"After we identified these traits for measuring drought tolerance, our next challenge was to make it possible to measure them quickly for many diverse species," Bartlett says.

To hasten the process, the UCLA team and XTBG froze small discs of leaf tissue in liquid nitrogen to break the cell walls and mix the cell sap. The saltiness of the cell sap could then be measured with an osmometer, which is typically used to measure osmotic potential in urine or blood.

The UCLA-XTBG team refined the method so that it can be applied in 10 minutes. They made measurements for 30 species from very different ecosystems, including tropical forest in China and the chaparral in California.

Wolpert writes for UCLA.

FASTER MEASUREMENT: UCLA life scientists discovered a new method to assess plants' drought tolerance quickly. Sealing a frozen leaf disc in an osmometer chamber allows scientists to measure its drought tolerance 30 times faster than previous methods.

PHOTO BY MEGAN BARTLETT/ UCLA DEPARTMENT OF ECOLOGY AND EVOLUTIONARY BIOLOGY