

NOTA DE PRENSA

Large-scale international study reveals how plants differ in their ability to adapt to climate change

With participation from the Spanish National Research Council (CSIC), the study shows that similar plant populations can evolve in very different ways in response to climate change.



Artistic rendering of Arabidopsis thaliana / Emma Vidal for Moisés Expósito Alonso..

Sevilla, 26 marzo de 2026. An international study involving the Spanish National Research Council (CSIC), an agency under the Ministry of Science, Innovation and Universities, has found that similar plant populations

can evolve in very different ways in response to climate change. The research, published in *Science*, shows that while evolution tends to follow partly predictable patterns under similar climatic conditions—even stressful ones—plants develop distinct adaptive dynamics when exposed to climates different from those of their origin. This is also the first time such a large-scale study has been conducted on plant survival under extreme and changing climates.

Different climates, different genetic varieties

For decades, ever since scientists first recognized the potential environmental damage caused by climate change, they have wondered whether plants can evolve quickly enough to adapt to a rapidly warming planet. Until now, however, most studies have consisted of isolated experiments carried out by individual research groups. This project therefore began by establishing a collaborative network of scientists who conducted simultaneous experiments across diverse climates in Western Europe, the Mediterranean, the Middle East, and North America.

The study—carried out by teams from several Spanish institutions—tracked and analyzed the evolutionary response to climate change of 70,000 individual plants representing different genetic variants of *Arabidopsis*. These were planted in 30 locations worldwide. Researchers simultaneously established and monitored 360 small plots over five years, spanning environments ranging from the snowy Alps to the heat of the Negev Desert, and from urban European areas to subtropical Austin in the United States.

The experiment allowed the plants to evolve without intervention, except for the removal of competing species that appeared naturally. The goal was to determine how quickly genetically diverse populations of the wild plant *Arabidopsis thaliana* would evolve under different climate stresses. The results made it possible to identify genetic variants associated with successful adaptation to various environmental contexts, as well as the conditions under which evolutionary capacity is overwhelmed by climatic pressure, ultimately leading to extinction.

“Data on the speed of evolution, together with the genetic changes that accompany it, are essential for building models that help identify which plants and animals are at risk as their environments change,” said the study’s lead author, Moisés Expósito-Alonso, a researcher and professor at the University of California, Berkeley.

Plants will continue to be affected by changes in local climates, making it crucial to develop strategies to understand their real capacity for adaptation—either on their own or with assistance. Ensuring their survival requires generating quantitative data to better understand rapid adaptation, make predictions, anticipate risks, identify climatic thresholds, and determine where attention should be focused.

Two possible strategies: resisting or avoiding extreme heat events

The research involved teams from several Spanish institutions, including CREAM, CSIC, IICG-URJC, the University of Granada, the University of Seville, and the Tragsatec Group. Within this collaborative framework, the Doñana Biological Station contributed by developing an experiment in the Sierra de Grazalema—one of the 30 study sites—where researcher Xavi Picó has been working with *Arabidopsis thaliana* since 2007, building a key time series for studying plant responses to environmental change.

“Adaptation to climate change is often misunderstood. It’s really about being able to cope with environmental fluctuations and long-term trends across different timescales,” explains Picó. “Natural selection shapes the genetic composition of populations to maintain their viability in different environments, but what matters most is how populations respond to environmental change, rather than how well adapted they are to a specific environment. Any organism that loses that ability to respond, for whatever reason, will struggle.”

In this context, maintaining genetic diversity and a certain degree of plasticity helps ensure greater biological success for populations in changing environments. In the case of *Arabidopsis thaliana*, experiments conducted in the Sierra de Grazalema show that the plant has adopted two strategies in response to extreme heat events. The first is to protect its photosynthetic system in order to withstand high temperatures for extended periods. The second is to avoid these events altogether, likely by adjusting its life cycle so that it is not present during such conditions.

“We are trying to understand how these strategies work and how plants choose between them, because that is the key to long-term survival: either endure the bad periods or avoid them. The challenge is how to do this without going extinct in the process,” Picó adds.

From a basic science perspective, this type of long-term experiment helps uncover fundamental biological mechanisms. “A better understanding of the biology of the organisms that share the planet with us should give us a clearer perspective for decision-making. Basic knowledge often seeps in gradually without us noticing, and from time to time it crystallizes into tangible advances, often in unexpected ways,” the researcher concludes.

Scientific reference:

X. Wu et al., *Rapid adaptation and extinction in synchronized outdoor evolution experiments of Arabidopsis*. *Science* 391, eadz0777 (2026). <https://doi.org/10.1126/science.adz0777>