

Which tree species fix the most carbon?

To answer this important question, an international consortium of scientists, coordinated by INRAE and Bordeaux Sciences Agro, studied the growth of 223 tree species planted in 160 experimental forests in different parts of the world. They found that conservative species, which are the most efficient at conserving their resources (nutrients, water, energy), generally grow faster in forests. These findings, which are available to forest managers and were published on 19 March 2025 in *Nature*, highlight the central role of local conditions in tree growth.

Forests provide many ecosystem services, including microclimate regulation, biodiversity preservation, air and water purification, and soil protection. Together with the oceans, they are one of the two most important carbon sinks, due to their capacity to store carbon in the soil and in tree biomass.

As such, promoting fast-growing trees could strengthen efforts to mitigate climate change. This raises a key question for forest managers: which tree species have the greatest mitigation potential?

INRAE and Bordeaux Sciences Agro conducted a study to identify the tree characteristics (also known as functional traits) that favour growth and thus CO₂ sequestration in biomass. The researchers coordinated an international consortium involving the French National Forest Office (ONF) and the French National Center for Private Forest Ownership (CNPF) to study the growth of 223 tree species planted in 160 experimental forests across the world (Western Europe, United States, Brazil, Ethiopia, Cameroon, South-East Asia, among others). The species were representative of all the major forest biomes.

Prevailing theory: acquisitive species grow quickly

Previous research had shown that under controlled conditions (often greenhouse experiments) species capable of efficiently acquiring resources (light, water, nutrients) generally grow quickly (e.g. maples, poplars, English oak, sessile oak). These acquisitive species have traits that help them maximize resource use (large specific leaf area, high specific root length) and improve their capacity to convert these resources into biomass (high maximum photosynthetic capacity, high nitrogen concentration in the leaves). Meanwhile, species that are more efficient at conserving their internal resources (nutrients, water, energy) than extracting external resources are known as conservative species (e.g. fir, downy oak, holm oak) and are assumed to grow more slowly.

New understanding: conservative species grow faster in forests

However, under real-world conditions in boreal and temperate forests, the researchers showed that conservative species generally grow faster than acquisitive species. This finding can be explained by the fact that these forests are generally located in areas with unfavourable growing conditions (low soil fertility, cold or dry climate), which gives conservative species an advantage since they are better able to resist stress and manage limited resources. In tropical rainforests, where the climate is potentially more favourable to plant growth, the two types of tree species show no differences on average.

The key role of local climate and soil for species choice

Beyond general trends at the major biome¹ scale, the researchers have shed light on the decisive role of local conditions. Growth conditions in some situations are sufficiently favourable for acquisitive species to grow faster than conservative ones. But the key is to ensure that species are adapted to their local environment. This means that in favourable climates and fertile soils, acquisitive species such as maples and poplars will grow faster and therefore fix more carbon than conservative species such as holm oaks, downy oaks and many types of pine trees. Conversely, in unfavourable climates and poor soils, conservative species will have the greatest potential to accumulate carbon in the biomass. This recent study gives forest managers yet one more tool to help mitigate climate change.

Reference

Augusto L., Borelle R., Boča A. et al. (2025). Widespread slow growth of acquisitive tree species. *Nature*, <https://doi.org/10.1038/s41586-025-08692-x>

Contacts:

Laurent Augusto – laurent.augusto@inrae.fr

Marie Charru – marie.charru@agro-bordeaux.fr

Joint Research Unit for Soil–Plant–Atmosphere Interactions

¹ The major terrestrial biomes represent vast geographical areas characterized by climate conditions and the species that grow there: tundras, deserts, savannahs, temperate forests, tropical forests, boreal forests, grasslands and the Mediterranean biome.