

# Amazon rainforest growth limited by lack of phosphorus

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Amazon Jungle, Brazil. Credit: Unsplash/CC0 Public Domain

Growth of the Amazon rainforest in our increasingly carbon-rich atmosphere could be limited by a lack of phosphorus in the soil, new research shows.

Higher concentrations of carbon dioxide (CO<sub>2</sub>) cause plants to grow more quickly, meaning they store more carbon.

This storage—especially in huge forests like the Amazon—helps to limit rising CO<sub>2</sub> levels, slowing climate change.

However, plants also need nutrients to grow, and the new study shows that availability of a particular nutrient, [phosphorus](#), could limit the Amazon's ability to increase productivity ([growth rate](#)) as CO<sub>2</sub> rises.

This could also make the rainforest less resilient to climate change, the researchers warn.

The study, published in the journal *Nature*, was carried out by an international team led by Brazil's National Institute of Amazonian Research (INPA) and the University of Exeter.

"Our results question the potential for current high rates of carbon uptake in Amazonia to be maintained," said lead author Hellen Fernanda Viana Cunha, from INPA.

"About 60% of the Amazon basin is on old soils with low phosphorus content, but the role of phosphorus in controlling productivity was unclear because most fertilization experiments in other parts of the world have been in more phosphorus-rich systems.

"Our experiment, the [Amazon Fertilization Experiment](#) (AFEX), examined the effects of adding phosphorus, nitrogen and base cations (other potentially key nutrients) in an old-growth, low-phosphorus area of the rainforest.

"Only phosphorus led to increased productivity in the first two years of the experiment.

"Having such rapid and strong responses to phosphorus, both above and below ground, is an indication that the whole system was functioning under severe phosphorous limitation."

Soil in [tropical regions](#) such as the Amazon generally formed millions of years ago, and some nutrients can be lost over time.

While nutrients such as nitrogen can be absorbed from the air by microorganisms associated with certain plants and soils, phosphorus is not available as a gas in the atmosphere—so once it becomes depleted there is little opportunity for levels to increase.

In the new experiment, two years with extra phosphorus caused significant increases in fine root growth (29%) and canopy productivity (19%).

Stem growth did not increase. Cunha said this may be because roots and leaves require more phosphorus than stems, and stem growth is a slower process.

Long-term monitoring of the experiment is required to determine whether a stem wood productivity response becomes apparent.

The findings have major implications not only for carbon storage, but also for the forest's resilience to climate change.

"To cope with and recover from increased threats such as droughts, we need the forest to be growing better than it used to," said Professor Iain Hartley, of the University of Exeter's Geography department.

"CO<sub>2</sub> fertilization could increase the forest's resilience, but our findings suggest phosphorus availability will limit that effect—and therefore the risks caused by climate change become increasingly important.

"In short, parts of the rainforest growing in low-fertility soils may be more vulnerable than is currently recognized."

Testing this suggestion is an urgent research priority. The [AmazonFACE](#) experiment—whose international team includes researchers from INPA and Exeter—is working to address this key priority.

The paper is entitled: "Direct evidence for phosphorus limitation on Amazon forest [productivity](#)."

**More information:** Direct evidence for phosphorus limitation on Amazon forest productivity, *Nature* (2022). [DOI: 10.1038/s41586-022-05085-2](#)

Provided by University of Exeter

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