

High CO₂ boosts plant respiration, potentially affecting climate and crops

February 9 2009



Andrew Leakey and assistants at work in the Soy FACE facility at Illinois. Photo by Don Hamerman

The leaves of soybeans grown at the elevated carbon dioxide (CO₂) levels predicted for the year 2050 respire more than those grown under current atmospheric conditions, researchers report, a finding that will help fine-tune climate models and could point to increased crop yields as CO₂ levels rise.

The study, from researchers at the University of Illinois and the U.S. Dept. of Agriculture, appears this week in the *Proceedings of the National Academy of Sciences*.

Plants draw CO₂ from the atmosphere and make sugars through the process of photosynthesis. But they also release some CO₂ during

respiration as they use the sugars to generate energy for self-maintenance and growth. How elevated CO₂ affects plant respiration will therefore influence future food supplies and the extent to which plants can capture CO₂ from the air and store it as carbon in their tissues.

While there is broad agreement that higher atmospheric CO₂ levels stimulate photosynthesis in C3 plants, such as soybean, no such consensus exists on how rising CO₂ levels will affect plant respiration.

"There's been a great deal of controversy about how plant respiration responds to elevated CO₂," said U. of I. plant biology professor Andrew Leakey, who led the study. "Some summary studies suggest it will go down by 18 percent, some suggest it won't change, and some suggest it will increase as much as 11 percent."

Understanding how the respiratory pathway responds when plants are grown at elevated CO₂ is key to reducing this uncertainty, Leakey said. His team used microarrays, a genomic tool that can detect changes in the activity of thousands of genes at a time, to learn which genes in the high CO₂ plants were being switched on at higher or lower levels than those of the soybeans grown at current CO₂ levels.

Rather than assessing plants grown in chambers in a greenhouse, as most studies have done, Leakey's team made use of the Soybean Free Air Concentration Enrichment (Soy FACE) facility at Illinois. This open-air research lab can expose a soybean field to a variety of atmospheric CO₂ levels - without isolating the plants from other environmental influences, such as rainfall, sunlight and insects.

Some of the plants were exposed to atmospheric CO₂ levels of 550 parts per million (ppm), the level predicted for the year 2050 if current trends continue. These were compared to plants grown at ambient CO₂ levels (380 ppm).

The results were striking. At least 90 different genes coding the majority of enzymes in the cascade of chemical reactions that govern respiration were switched on (expressed) at higher levels in the soybeans grown at high CO₂ levels. This explained how the plants were able to use the increased supply of sugars from stimulated photosynthesis under high CO₂ conditions to produce energy, Leakey said. The rate of respiration increased 37 percent at the elevated CO₂ levels.

The enhanced respiration is likely to support greater transport of sugars from leaves to other growing parts of the plant, including the seeds, Leakey said.

"The expression of over 600 genes was altered by elevated CO₂ in total, which will help us to understand how the response is regulated and also hopefully produce crops that will perform better in the future," he said.

Source: University of Illinois at Urbana-Champaign

Citation: High CO₂ boosts plant respiration, potentially affecting climate and crops (2009, February 9) retrieved 20 April 2024 from <https://phys.org/news/2009-02-high-co2-boosts-respiration-potentially.html>

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