

Coffee with more gas

Coffee plants grow larger and produce more when there is more CO₂ in the atmosphere

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PUBLISHED IN SEPTEMBER 2013

An atmosphere richer in carbon dioxide (CO₂) – as our atmosphere is expected to be in the coming decades as a consequence of continued gas emissions from the burning of forests and fossil fuels – could benefit the production of coffee, one of Brazil's principal agricultural crops, and perhaps neutralize the loss in productivity caused by the increase in temperature and the intensification of droughts and floods, according to the initial results obtained from an experimental crop grown at the Brazilian Agricultural Research Corporation (Embrapa) facility in Jaguariúna.

For two years, coffee plants maintained in six octagons measuring 10 meters in diameter received doses of CO₂ at a concentration of 550 parts per million (ppm), simulating the atmosphere as it might be at the end of this century, when atmospheric CO₂ could be as high as 760 ppm. Coffee plants grown in six other octagons received only the level of atmospheric CO₂ prevailing today, a concentration of 440 ppm (see *Pesquisa FAPESP Issue N° 198*). Comparatively, the plants that received more CO₂ – controlled by sensors that activated automatically according to the direction and speed of the wind –

were taller and had longer branches, a thicker stem, and larger leaves.

The coffee plants that received more CO₂ also produced more coffee cherries, according to Raquel Ghini, coordinator of the project entitled *Effects of high atmospheric CO₂ concentration in open-top chambers and Free Air CO₂ Enrichment (face) systems on photosynthesis and natural resistance mechanisms of coffee plants to coffee rust*. According to Ghini, it is too soon to announce the final gain in productivity because it represents the results from only one harvest. Because coffee plants alternate years of high and low productivity, “we need at least two harvests to obtain more consistent values,” she says. The quality of the beans is being assessed by experts from the Campinas Institute of Agronomy.

The coffee plants grew larger in an atmosphere enriched with CO₂ because the photosynthesis rate increased by 60%, from 10 to 16 micromoles of CO₂ per foliar square meter per second. “More CO₂ in the atmosphere means more substrate on which the plant can perform photosynthesis,” says Emerson da Silva, a researcher at the Botanic Institute of São Paulo, which is responsible for the analysis.

It is through photosynthesis that plants transform sunlight and CO₂ into carbohydrates. With more carbohydrates in its tissues, a plant will be able to grow larger and produce more fruit or, as we have already observed with soy, synthesize more chemical compounds that will help the plant defend itself against disease-causing microorganisms. In coffee plants kept in open-top greenhouses with a 760 ppm concentration of CO₂, the Botanic Institute team observed an increase in the capacity to resist light, the light saturation point, from 600 to 800 micromoles of photons per square meter per second. “The plants became more capable of receiving more light,” says Silva.

THE EXAMPLE FROM MINAS

Fabio DaMatta, professor at the Federal University of Viçosa (UFV), believes that the benefits obtained from a high atmospheric concentration of CO₂ could neutralize many of the harmful effects produced by higher temperatures and changes in precipitation. According to a recent study, the effect could be the same as that for soybean, rice, and wheat, for which a significant decline in production is predicted to occur in the coming de-



Precocious blooms: the coffee plant grows larger and produces more cherries in an atmosphere richer in CO₂ (below)

cares, even when considering only the rise in temperature.

If these optimistic predictions prove true, it would be possible to prevent crops such as coffee from migrating to more temperate regions in the south of Brazil. “The new zoning pattern for coffee-growing cannot be determined unless we also consider the increase in CO₂ concentration,” DaMatta says. The increase in atmospheric concentration of CO₂ could explain “some results that were unthinkable not that long ago,” as he puts it. For example, it could explain why coffee plants are growing and producing in some regions of Minas Gerais

State, where the average annual temperature is 24.5° Celsius, 1.5 degrees above the limit that the plant is supposed to withstand. “Some of the success of cultivation in those regions may, possibly, be due to the increase in CO₂ content in the atmosphere.”

The studies conducted so far – and presented in early September in Jaguariúna – indicate that this coffee plant may be susceptible to fewer diseases; however, the scenario is uncertain. “Some pests and diseases will probably increase and others decrease because when plants grow bigger, they may create a more humid and cooler microclimate, which

would be more favorable to fungi and bacteria,” Ghini says.

The pasture grass known as Surinam grass (*Brachiaria decumbens*), the principal food of cattle in Brazil, grew taller and exhibited more biomass and fiber when subjected to an atmosphere richer in CO₂ than at present levels – among the coffee plants – than the same grass that did not receive extra doses of CO₂. However, “the nutritive value is not as high,” observes Adibe Abdalla, a researcher from the University of São Paulo (USP). In addition, the fiber was of lower quality, meaning that when digested by cattle, it might produce more methane, one of the gases associated with climate change. ■



Projects

1. *Effects of high atmospheric CO₂ concentration in open top chambers and Free Air CO₂ Enrichment (FACE) systems on photosynthesis and natural resistance mechanisms of coffee plants to coffee rust (12/08875-3); Grant mechanism Regular Line of Research Project Award; Coordinator Emerson Alves da Silva – Botanic Institute; Investment R\$198,255.31 (FAPESP).*

2. *Impact of the increase in concentration of atmospheric carbon dioxide and availability of water on the growing of coffee in a FACE (“Free Air CO₂ Enrichment”) experiment; Coordinator Raquel Ghini – Embrapa Meio Ambiente; Investment R\$2,627,048.96 (Embrapa).*