

More CO₂ makes photosynthesis more efficient

The climate is changing as emissions of CO₂ continue to increase. Plants are changing too, shows research by PhD candidate Sophie Zwartsenberg. Higher levels of carbon dioxide in the atmosphere are making their photosynthesis more efficient. Text Roelof Kleis

This improved efficiency is thanks to rubisco, the key enzyme in photosynthesis. Rubisco takes CO₂ and turns it into glucose. But it can also capture oxygen instead of CO₂, starting a process called photorespiration. The difference between the two processes is evident in the glucose that is formed. To see that, you need to zoom in on the small proportion of glucose molecules that a heavy hydrogen atom (deuterium) has been incorporated into naturally. Deuterium is a hydrogen isotope with an extra proton in the nucleus. NMR equipment

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can distinguish between photosynthesis and photorespiration by detecting this 'heavy glucose'. Zwartsenberg has made use of this gift of nature. She studied the glucose in the annual rings of the Australian red cedar, *Toona ciliata*. She used trees from Australia, Thailand and Bangladesh covering more than a century. The results left no doubt: over the past century, photosynthesis by the trees has increased due to the higher concentration of CO₂ in the atmosphere. 'The trees' physiology has changed,' explains Zwartsenberg. 'With the increase in the amount of CO₂ in the atmosphere, the ratio of carbon dioxide uptake (photosynthesis) to oxygen uptake (photorespi-

ration) has shifted in favour of photosynthesis.' In other words, photosynthesis has become more efficient. It seems logical to see the higher efficiency as proof of 'CO₂ fertilization', the assumed positive effect of climate change on plant growth.

No proof

However, Zwartsenberg cannot and will not draw that conclusion. 'The change we are measuring says nothing about growth. So it's not proof of increased growth thanks to CO₂ fertilization, as some media reported. I did my best to avoid implying that, but it's difficult to get a nuanced message across on this topic. I don't even know whether the increased efficiency leads to more sugar being formed. That's probably the case, but I don't know.' A tree can be efficient but still not produce much sugar, explains Zwartsenberg. 'I think that's the reason why the smaller trees were more efficient than the larger ones in this study. Smaller trees get less light. That restricts the amount of photosynthesis, so they use up less CO₂. The concentration of CO₂ in the leaves increases, rubisco captures more CO₂ and so what photosynthesis there is, is more efficient.'

Zwartsenberg discovered the change in the physiology after studying just nine trees. 'Three per location and only three to five samples per tree, spread across the annual rings. That's a very small dataset, and yet the results are so clear.' The limited size is for practical reasons. 'It takes two weeks to process four samples. And that's just the lab work, extracting the glucose from the wood.'



Researcher Sophie Zwartsenberg doing fieldwork in Australia. ♦ photo Iftakharul Alam