Long-Term impact of elevated CO_2 exposure on grapevine physiology (*Vitis vinifera* L. cvs. Riesling & Cabernet Sauvignon)

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Abstract (250 words)

Over the next 25 years, the Intergovernmental Panel on Climate Change (IPCC 2013) predicts a ~20% increase in atmospheric carbon dioxide (CO_2) concentration compared to the current level. Concurrently, temperatures are steadily rising. Grapevines, known for their climate sensitivity, will show changes in phenology, physiological processes and grape compositions in response. Investigating eco-physiological processes provides insights into the response of field-grown grapevines to elevated CO_2 conditions. A Free Air Carbon Dioxide Enrichment (FACE) facility was established in the Rheingau region of Germany. Two grapevine varieties (*Vitis vinifera* L., cvs. Riesling and Cabernet Sauvignon) were planted, with the VineyardFACE comprising three rings with ambient atmospheric CO_2 (approx. 400 - 420 ppm from 2014 to 2023, aCO_2) and three rings with elevated CO_2 concentration (+20% to ambient; eCO_2). Abaxial leaf imprints revealing that both varieties reached their highest stomatal density in the early years of the study. Riesling leaves exhibited a higher density compared to Cabernet Sauvignon. In a warmer year like 2020, both varieties responded with a lower density. With continuously exposition to eCO_2 the differences in stomatal conductance became increasingly negligible. The net photosynthesis of both varieties peaked in the later and warmer period of the study (2018 – 2022), with plants under elevated CO_2 concentration achieving significantly higher assimilation rates. Accompanying this, plants under aCO_2 conditions exhibited a higher non-photochemical quenching, whereas electron transport rate and photochemical quenching under eCO_2 conditions were higher. Long-term studies are necessary to estimate the consequences for growers in the future.

Keywords: climate change, viticulture, grapevine physiology, elevated CO_2 concentration, FACE facility