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Water status response of *Vitis vinifera* L. cv Cabernet Sauvignon during the first years within the long-term VineyardFACE (Free Air Carbon dioxide Enrichment) study

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Abstract (250 words)

Understanding grapevine responses to increasing atmospheric CO_2 (aCO_2) concentrations is crucial for assessing the impact of climate change on viticulture. Previously, at the VineyardFACE (Free Air Carbon dioxide Enrichment) experiment in Geisenheim, leaf gas exchange measurements were made as *Vitis vinifera* cv. Cabernet Sauvignon established from planting (2014 to 2016) under aCO_2 or elevated CO_2 (eCO_2, aCO_2 + 20%) concentrations. Contrary to many preceding observations with grapevines and other perennial plant species the young vines showed an increased intrinsic water use efficiency (WUE_i) that was mainly associated with an increase in net assimilation (A) rather than a decrease in stomatal conductance (g_s) under eCO_2.

To determine the impact of this stomatal conduction response to eCO_2 on whole vine water use, sap-flow gauges were installed for subsequent seasons (2016/2017), with complementary measurements of leaf gas exchange, pre-dawn leaf water potential (Ψ_{pd}), soil water content and recording of weather data. Furthermore, a vineyard water balance model was used to test the implications of the eCO_2 response, and possible explanations. Net assimilation and intrinsic water use efficiency values were higher for Cabernet Sauvignon under eCO_2 conditions, likewise transpiration rates (E) and stomatal conductance. Results were supported through whole vine transpiration measurements, pointing to a higher water use of young vines under eCO_2. The difference in daily vine water use between both CO_2 treatments was higher on days of high evaporative demand. Further, pre-dawn leaf water potentials were slightly lower under aCO_2, indicating a potentially lower risk for drought stress for young vines under eCO_2.

Keywords: grapevine, climate change, carbon dioxide, water status, gas exchange, transpiration model