Heat and drought stress associated with a naturally occurring heat wave negatively affected the carbon and water balance of olive trees (Olea europea L.)

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Global warming will increase the number and severity of simultaneous droughts and heatwaves. This will have severe implications for agricultural sustainability in semi-arid regions. The absence of evapotranspirative cooling can contribute to the warming of temperatures in arid or drought-affected areas, particularly during hot and dry periods. Tree crops such as olive (Olea europaea L.) are particularly vulnerable to the long-term impacts of heat stress and water deficit. An understanding of the physiological responses of these stresses when combined is essential to mitigation and phenotyping efforts to climate-proof agriculture. We monitored biochemical and diffusive limitations to photosynthesis alongside the efficiency of mechanisms to enhance protection against photo-oxidative stress through the dissipation of excess energy in olive trees during a naturally occurring heatwave. Heat stress and water deficit impaired CO_2 assimilation through reduced ribulose-1,5-bisphosphate carboxylase/oxygenase (RubisCO) activity. Higher temperatures induced stomatal closure, exacerbating the impact of heat stress by reduced transpirative cooling. Heat stress also impaired photosystem II in olives resulting in lower capacity to utilize energy for photochemistry. The strong impact of heat stress when combined with water deficit negatively affected the carbon and water balance of the olive trees – illustrating the severe threat posed by climate change to the sustainability of olive production.