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Thinning management increases tree growth by delaying the drought onset in a Mediterranean evergreen oak coppice

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Forest management by thinning is known to improve tree growth and resistance to stress due to a reduced competition for resources. In strongly water limited ecosystems such as Mediterranean woodlands, thinning effect occurs mainly through an improvement of the water balance. Building on the recent advances regarding the 'sink limitation' paradigm that proposes a direct control of tree growth by phenology and climatic constraints decoupled from the carbon assimilation, we investigated if the thinning effect on tree growth could be predicted by a water balance model in a Mediterranean coppice. We used results from a long-term thinning experiment (30 years) conducted in a Quercus ilex forest in southern France and from a 15 years rainfall reduction experiment in plots with different tree densities to test our hypothesis. Thinning resulted in significantly increased stem growth and reduced mortality of the remaining stems. Integrating the change in leaf area due to thinning in a water balance model, together with knowledge on tree growth phenology, allowed to predict the thinning effect on growth with a good accuracy for moderate thinning intensity treatments. Experimental and simulation results both indicate that drought onset is delayed by thinning, which explains most of the growth increase. Stand density and experimentally increased drought interactively shape forest productivity and drought sensitivity. Overall, thinning was observed to compensate for increased drought condition and to further stimulate allocation to acorn production. Our experimental and modeling approach opens the way to decipher the relative impacts of drought and competition in tree growth and to propose a management tool to optimize the tree density as a function of current or future water limitation in Mediterranean evergreen woodlands.