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Title
Widespread holm oak dieback in Mediterranean forests: the roles of carbon stress and hydraulic failure under recurrent drought events

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Abstract

Mediterranean ecosystems are usually considered resilient to arid conditions, because of their capability to cope with and recover after severe stress events. However, in recent years, extensive tree dieback related to drought events have occurred in different Mediterranean forests. The aim of our research is to investigate the causes of widespread mortality of *Quercus ilex* observed in Tuscany. Physiological traits were measured through different seasons in an experimental site established in the Maremma Natural Reserve, characterized by areas with high mortality rates of *Q. Ilex*. To investigate specific physiological and biochemical mechanisms underlying *Q. ilex* dieback, we have also conducted a pot experiment on three-years old seedlings subjected to progressive water stress followed by rewatering, whereas control plants were maintained in well-watered conditions. In both experiments, the following measurements were carried out: water relations, gas exchanges, chlorophyll fluorescence, carbohydrates, BVOCs, epidermal content of flavonols and chlorophyll. In addition, on shoots collected from plants of the pot experiment we performed target expression analyses focusing on genes involved in drought responses. Results of both studies led us to hypothesize that *Q. ilex* dieback observed in the Maremma Natural Reserve may be attributed to hydraulic failure. Although holm oak is considered an isohydric species subjected to carbon starvation caused by fast stomatal closure in response to water deficit, xylem embolism may occur under recurrent droughts compromising its ability to recover from severe stresses. Furthermore, both qualitative and quantitative changes in BVOC emissions were found under severe water stress. Considering the intrinsic high emission rates of monoterpenes of this species, variations in the production of these compounds may have implications for the atmospheric biochemistry in Mediterranean areas. In conclusion, our results contribute to elucidate possible mechanisms underpinning recent holm oak forest mortality and provide guidance for understanding Mediterranean forest diebacks under climate changing conditions.

Keywords
drought-inducible genes; gas exchanges; Mediterranean ecosytems; Quercus ilex; secondary metabolites; water stress; xylem vessels.