Morphological responses and recovery potential of *Fagus sylvatica* L. and *Quercus robur* L. seedlings under water deficit and soil drought conditions

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The observed increase in the frequency and intensity of droughts affects the resilience of forest ecosystems. Although many studies have focused on the impact of drought on aboveground growth, less is known about species-specific differences in belowground resistance and their long-term recovery potential. Understanding the complexity of tree response to hydrological stress is particularly important for ecologically and economically important species, such as European beech (*Fagus sylvatica*) and pedunculate oak (*Quercus robur*). Our study aimed to identify and compare the effects of water deficit and soil drought on morphological changes in the leaves, shoots, and root systems of beech and oak, and to assess the species-specific capacity for recovery.

To address this, we conducted an experiment with 1,440 one-year-old seedlings under controlled irrigation conditions, including three treatments: control, water deficit, and soil drought. The analyses included morphological parameters of the above- and belowground parts, such as height and root collar diameter, as well as biomass allocation and root system architecture. These analyses were performed on a total of 220 seedlings sampled after stress application, at the end of the growing season, and after an additional year of recovery growth.

Soil drought significantly reduced height growth in both species, whereas water deficiency had no significant effect. Oak showed greater stability and resistance to soil water limitations compared to beech. Interestingly, water deficiency stimulated belowground biomass, length, and surface areas in the roots of both species. After a year of recovery, we found no differences in biomass allocation among treatments, but seedlings previously exposed to severe drought still showed reduced height and root collar diameter.

Our results show that water availability strongly shapes the morphological responses of the studied species. Both species exhibited compensatory mechanisms under water deficit, especially in belowground traits, while severe drought reduced both aboveground and belowground biomass. Furthermore, our study indicates that drought has long-lasting negative effects on growth. These findings highlight species-specific responses to hydrological stress and provide guidance for optimizing irrigation to produce seedlings better adapted to drought.