Temperate tree species show identical response in tree water deficit but different sensitivities in sap flow to summer soil drying

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Author(s) Brinkmann, Nadine; Eugster, Werner; Zweifel, Roman; Buchmann, Nina; Kahmen, Ansgar
Author(s) at UniBasel Kahmen, Ansgar ; Brinkmann, Nadine ;
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Temperate forests are expected to be particularly vulnerable to drought and soil drying because they are not adapted to such conditions and perform best in mesic environments. Here we ask (i) how sensitively four common temperate tree species (Fagus sylvatica, Picea abies, Acer pseudoplatanus and Fraxinus excelsior) respond in their water relations to summer soil drying and seek to determine (ii) if species-specific responses to summer soil drying are related to the onset of declining water status across the four species. Throughout 2012 and 2013 we determined tree water deficit (TWD) as a proxy for tree water status from recorded stem radius changes and monitored sap flow rates with sensors on 16 mature trees studied in the field at Lägeren, Switzerland. All tree species responded equally in their relative maximum TWD to the onset of declining soil moisture. This implies that the water supply of all tree species was affected by declining soil moisture and that none of the four species was able to fully maintain its water status, e.g., by access to alternative water sources in the soil. In contrast we found strong and highly species-specific responses of sap flow to declining soil moisture with the strongest decline in P. abies (92%), followed by F. sylvatica (53%) and A. pseudoplatanus (48%). F. excelsior did not significantly reduce sap flow. We hypothesize the species-specific responses in sap flow to declining soil moisture that occur despite a simultaneous increase in relative TWD in all species reflect how fast these species approach critical levels of their water status, which is most likely influenced by species-specific traits determining the hydraulic properties of the species tree.

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