Predictors and mechanisms of the drought-influenced mortality of tree species along the isohydric to anisohydic continuum in a decade-long study of a central US temperate forest

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6 Jan 2015

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Abstract

Using decade-long continuous observations of tree mortality and predawn leaf water potential (ψ_{pd}) at the Missouri Ozark AmeriFlux (MOFLUX) site, we studied how the mortality of important tree species varied along the isohydric to anisohydric continuum and how such variations may be predicted. Water stress determined inter-annual variations in tree mortality with a time delay of one year or more, which was predicted by predawn leaf water potential integral (PLWPI), mean effective precipitation interval (a time period with no daily precipitation rates exceeding a threshold) with a daily threshold precipitation at 5 mm day^{-1} (MEPI5), and precipitation variability index (PVI). Positive temperature anomaly integral (PTAI) and vapor pressure deficit integral (VPDI) also worked reasonably well, particularly for moderate droughts. The extreme drought of the year 2012 drastically increased the mortality of all species in the subsequent year. Regardless of the degree of isohydry and drought intensity, the ψ_{pd} of all species recovered rapidly after sufficiently intense rain events. This, together with a lack of immediate leaf and branch desiccation, suggests that hydraulic disconnection in the xylem was absent even during extreme drought and tree death was caused by significant but indirect effects of drought. We also found that species occupying middle positions along the isohydric to anisohydric continuum suffered less mortality than those at either extremes (i.e., extremely isohydric or extremely anisohydric). Finally, our study suggested that species differences in mortality mechanisms can be overwhelmed and masked in extreme droughts and should be examined in a broad range of drought intensity.

54 **Key words**: Drought, isohydric, anisohydric, predawn leaf water potential, tree mortality
55 predictors