Different transpiration and growth patterns of the black locust plantation and natural oak forest on China's Loess Plateau

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Abstract

Restoration of natural secondary forests and afforestation of introduced tree species are major effective measures for revegetation. The semi-arid Loess Plateau region, characterized by fragile ecosystems and severe soil erosion, is a key area for ecological restoration and protection in China. To illustrate water use characteristics and adaptation to drought in the main forests in this area, we monitored the xylem sap flow of two typical forest communities, a secondary natural forest dominated by oak (*Quercus liaotungensis*) and a pure plantation of black locust (*Robinia pseudoacacia*), during 2011-2019 using Granier-type thermal dissipation probes. Solar radiation, air temperature, relative humidity, precipitation, and soil water content were measured simultaneously. Throughout the whole study period, the mean diameter at breast height and total sapwood area increased by 4.5 cm and 1.10 m ^{2} ha $^{-1}$ in the oak forest and by 1.0 cm and 0.22 m ^{2} ha $^{-1}$, respectively, in the black locust plantation. The monthly stand transpiration was jointly determined by phenological and meteorological factors. At the annual timescale, transpiration of the oak stand was significantly correlated with potential evapotranspiration and rainfall in the previous year, whereas a significant positive relationship was detected between stand transpiration and soil water content in the black locust stand. The analyses of differences between dry and wet years showed that, the oak forest exhibited significantly different parameters in the regression analysis of stand transpiration to vapor pressure deficit. While only one parameter was clearly distinct in the black locust plantation, suggesting that its transpiration status did not fully recover even in wet years. The management of black locust plantations with weakened growth conditions should be adjusted under prolonged drought conditions. In contrast, oak forest can maintain the water balance and stable growth by efficiently controlling stomatal behavior.

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