Removing Adult Overstory Trees Stimulates Growth and Transpiration of Conspecific Juvenile Trees

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Removing Adult Overstory Trees Stimulates Growth and Transpiration of Conspecific Juvenile Trees

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Abstract

During the last century, the density of Ashe juniper (*Juniperus ashei* Buchholz) has greatly increased in oak savannahs of central Texas. Recently, juniper removal has been advocated as a regional water conservation tool. In this study, we investigated whether juvenile trees released from an overstory canopy after clearing exhibited accelerated growth and water consumption. We compared leaf-level transpiration (E_l) and carbon assimilation (A_{net}) rates among juvenile juniper under three different treatment scenarios: 1) in the **open**, 2) under an adult juniper **canopy** or 3) recently **released** by the removal of an adult juniper canopy. Released plants apparently grew faster and used more water than other juvenile trees; average A_{net} of released plants was 94%–162% greater ($P < 0.05$) than those beneath an adult canopy and 22%–44% greater than open-grown plants. Furthermore, average E_l of released plants was 22%–72% greater than those beneath an adult canopy and 13%–22% greater than open-grown plants. These differences persisted for at least two years after treatment. Rates of A_{net} were particularly elevated in released plants compared to other plants during periods of low water stress; whereas E_l tended to be higher in released plants compared to other plants at all levels of water availability. Our evidence suggests released plants have better access to water, because at two out of three study sites, predawn leaf water potential (Ψ_p) was significantly more favorable for released plants than open-grown or under-canopy plants ($P < 0.05$). Although adult canopy removal temporarily reduced leaf area of juniper on a community level, and likely total water use, we demonstrated that released juveniles, at a minimum, partially compensated for the reduced overstory by increasing rates of water use and growth.

Resumen

Durante el siglo pasado la densidad de "Ashe juniper" (*Juniperus ashei* Buchholz) se ha incrementado grandemente en las savanas de encino de la región central de Texas. Recientemente la remoción de "Juniper" se ha enfocado como una herramienta de conservación de agua. En este estudio investigamos si los árboles juveniles liberados de una cobertura superior, después de un aclareo, muestran un crecimiento y consumo de agua acelerados. Comparamos las tasas de transpiración a nivel de hoja (E_l) y la asimilación de carbón (A_{net}) entre arboles juveniles bajo tres tratamientos: 1) área **abierta**, 2) bajo una **cobertura** de árboles adultos y 3) recientemente **liberados** por la remoción de la cobertura de árboles adultos de "Juniper." Las plantas liberadas aparentemente crecieron mas rápido y usaron mas agua que otros árboles juveniles; el promedio de A_{net} de las plantas liberadas fue 94%–162% mayor ($P < 0.05$) que aquellas debajo de la vcoberura de arboles adultos y 22%–44% mayor que la de las plantas creciendo en espacios abiertos. Además, el promedio de E_l de las plantas liberadas fue 22%–72% mayor que el de las plantas bajo la cobertura de plantas adultas y 13%–22% mayor que las del espacio abierto. Estas diferencias persistieron por al menos dos a 4s después de aplicar los tratamientos. Durante los periodos de estrés por poco agua, las tasa de A_{net} fueron particularmente elevadas en las plantas liberadas en comparación con las otras plantas; mientras que el E_l tendio a ser mayor enlas plantas liberadas en comparación con las otras plantas en todos los niveles de disponibilidad de agua Nuestra evidencia sugiere que las plantas liberadas tienen un mejor acceso al agua, porque en dos de los tres sitios de estudio el poetncial de agua de la hoja predawn (Ψ_p) fue significativamente mas favorable para las plantas liberadas que para las plantas creciendo en espacios abiertos o bajo la copa de árboles ($P < 0.05$). Aunque la remoción de la copa de plantas adultas redujo temporalmente el área foliar del "Juniper" a nivel de comunidad y probablemente el uso total de agua, nosotros demostramos que las plantas juveniles liberadas, al menos, compensaron parcialmente la reducción de copa al incrementar las tasas de uso de agua y crecimiento.

Key Words: brush management, ecohydrology, Edwards plateau, *Juniperus ashei*, leaf carbon assimilation, savanna

INTRODUCTION

Juniper has increased in cover and relative abundance throughout the western United States, including the Great Basin (Blackburn and Tueller 1970; Tausch et al. 1981; Miller and Rose 1999; Wall et al. 2001), northwest Texas (Ansley et al. 1995; Ueckert et al. 2001), and oak savannas in the Edwards Plateau region of central Texas (Archer 1994; Van Auken 2000). This expansion has been attributed in part to reduced fire frequency (Belsky 1996; Miller and Rose 1999; Van Auken 2000) and to livestock herbivory (Archer 1994; Belsky 1996; Miller and Rose 1999; Van Auken 2000). Vegetation shifts from grass to tree dominance impact a variety of ecosystem processes, including disturbance regimes, carbon and nutrient cycling, and soil stability (Schlesinger et al. 1990; Archer et al. 2001).

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