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Grass effects on tree (*Prosopis glandulosa*) growth in a temperate savanna

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Abstract

The majority of studies on woody–herbaceous interactions have focused on the effects of trees on grasses; relatively few have looked at grass effects on adult trees. In a two-year study in a temperate savanna in northern Texas, tree (*Prosopis glandulosa*) basal area increased significantly following removal of associated grasses, the response being highly variable in time and space. Tree response to grass removal was strongest on shallow, clayey soils, but was evident only during the year subsequent to treatment. Low intensity surface fire enhanced growth of adult trees, but the magnitude of the response was inconsistent among sites. Clipping of grasses (proxy for grazing) had no effect on tree growth. Contrasts between the clipping and removal experiments suggest clipping may not have been frequent or intense enough to elicit a tree response; or that it is the presence/absence of grasses rather than their aboveground biomass which impacts trees. Enhanced tree growth and foliar N and P content associated with disturbance to the grass layer on shallow sites where vertical segregation of woody plant and grass roots and soil resources are constrained, may reflect reductions in competition for soil moisture and elevated soil N and P availability following fire.

Keywords: Competition; Fire; Mesquite; *Prosopis glandulosa*; Savanna; Soil water

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1. Introduction

Savannas are characterized by mixtures of woody and herbaceous lifeforms. Factors determining the relative abundance and productivity of these contrasting lifeforms involve interactions between climate (primarily amount and seasonality of rainfall), soils (primarily texture and depth), herbivory (grazing vs. browsing) and fire. The vast majority of studies on woody–herbaceous interactions have examined tree effects on grasses. Studies of grass effects on woody plant seedling establishment are common; but relatively few studies have examined the effect grasses might have on adult trees (Scholes and Archer, 1997), or how grazing and low intensity surface fire might modify this relationship.

The grass layer can interact directly with trees through resource competition, or indirectly through the intermediary effects of fire, which may induce tree mortality, particularly of juveniles (Menaut et al., 1990) or stressed trees (e.g. Yeaton, 1988), and benefit surviving trees by increasing soil resources post-burn (Jensen et al., 2001). Grasses, with their relatively shallow, dense, fibrous root systems, may actively compete with trees for resources (Ehleringer et al., 1991; Dawson and Pate, 1996), either directly, if they coincide with shallow tree roots in the upper soil horizons, or indirectly, by intercepting water and nutrients and reducing their percolation to deeper portions of the soil profile where tree roots may be more abundant. If this model is correct, then disturbances that reduce above and/or belowground production and resource utilization by the herbaceous layer (e.g. fire, grazing) should benefit tree growth.

Soil characteristics mediate interactions between trees and grasses. For example, the extent of grass–tree competition may be a function of soil texture, whereby the intensity of herbaceous competition is relaxed on coarse-textured soils where water and nutrients are more likely to percolate deeper into the soil profile and intensified on fine-textured soils where water is more likely to be retained in upper soil horizons (e.g. Knoop and Walker, 1985). On shallow soils where woody and herbaceous roots are confined to the same volume, grass-on-tree competition may be more intense than on deeper soils, where vertical stratification of lifeform root systems can occur. Honey mesquite (*Prosopis glandulosa* Torr.) trees in savannas of the southern Great Plains may rely heavily on shallow lateral roots, particularly where available soil volume is reduced (Ansley et al., 1990, 1991, 1992b; Cuomo et al., 1992). Herbaceous effects on tree growth may therefore be inversely proportional to soil depth.

The role of fire in maintenance of savannas ranges from one of woody plant exclusion, to one of generating a composition dominated by fire-tolerant woody and herbaceous species (Scholes and Walker, 1993). Consequently, most savanna research regarding the direct effects of fire has examined woody plant mortality and vegetative regeneration of damaged adult trees. However, individuals of larger stature often escape with minimal canopy damage, especially in low intensity surface fires (Scholes and Walker, 1993). Fire is known to enhance post-fire tree seedling establishment by increasing available nitrogen, phosphorus, potassium, calcium, and magnesium in the mineral soil (Christensen, 1977; McKee, 1982; Covington and Sackett, 1984; Schoch and Binkley, 1986; Jensen et al., 2001). Consequently, it has been proposed that low intensity understorey fires will stimulate growth in fire resistant adult trees (de Ronde et al., 1990). However, this hypothesis has not been widely tested.

P. glandulosa savannas and woodlands characterize much of the southern Great Plains in North America. There is a substantial body of work on its effects on herbaceous