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Interactive effect of tree canopy cover and defoliation on growth of *Festuca pallescens* in Mediterranean silvopastoral systems in NW Patagonia, Argentina.

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Introduction

The "limiting resource model" proposes that grass growth after defoliation under tree canopy cover is lower than under full sun situation and further decreases with increased tree canopy cover and frequency of defoliation. This response is directly related to amount of biomass loss that limits the radiation or focal resource uptake. Testing the "limiting resource model" in Mediterranean silvopastoral systems could allow to determine which resource –radiation or water- is the focal one under these conditions, and therefore, if defoliated plants under tree canopy cover could grow better than in open situations due to facilitation effects of trees on their water status.

The objective of this study was to evaluate the effect of different levels of tree canopy cover on the growth and dry matter production of *Festuca pallescens* in N.W. Patagonia, in interaction with different intensity and frequency of defoliation. The hypothesis was that the morphophysiological changes caused by defoliation increase the positive effects (facilitation) and decrease the negative effects (competition) caused by the tree layer on the herbaceous layer in Mediterranean silvopastoral systems such as the studied model.

Materials and methods

The study was conducted during three growing seasons at Lemú Cuyén Ranch (40,29º S; 71,13º W), Neuquen province, Argentina. The average annual rainfall is about 800 mm, with 185mm in spring-summer, resulting in summer water deficit. The maximum and minimum annual temperatures are 17,1ºC and 2.1° C, respectively. Precipitation fallen differed in the three studied seasons, leading to relatively wet and dry seasons.

In a stand of Pinus ponderosa (2 ha), 10 plots (1600 m2 each) were established and two thinning treatments were applied, 500 trees ha^{-1} and 350 trees ha^{-1} (n = 5). In adjacent open areas, 5 plots were also placed. Within these plots, 2 m x 2 m subplots were established containing 3 to5 *Festuca pallescens* plants on which the defoliation treatment was applied. The evaluated situations, in addition to a control without defoliation, were: a) Intensity of defoliation: removal 50 or 70% of the aboveground biomass only once at the beginning of the season, b) Defoliation frequency: low frequency, applying a single defoliation of 50 % of aboveground biomass; high frequency, applying the same treatment every two months.

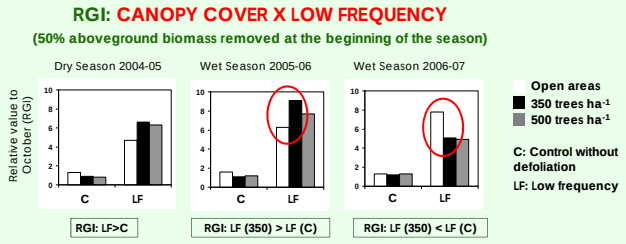
In all treatments, every month between October to April, the relative growth index (RGI) was estimated. Measurements were expressed as a proportion of the value in the initial month (Oct). At the end of the season, the plants were harvested to estimate biomass production.

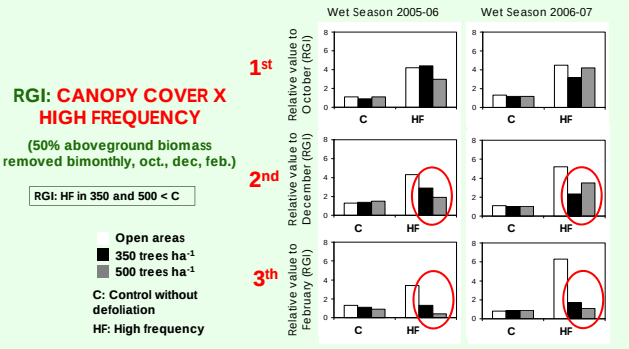
Air temperature and soil water content were measure periodically in all treatments.

Results

The daily average temperature in the coldest months of the year (July-September) was 0.7°C and 0.3°C higher under 350 trees ha^{-1} and 500 trees ha^{-1} respectively, compared to the average temperature in the open grassland. During warm February and March, air temperature and atmospheric demand were lower under tree canopy cover with marked differences in temperature between the control and the highest canopy cover.

In the dry season, a negative effect of tree canopy cover was observed on soil water content in the 0-20 cm layer between October to January. However, in March, when extreme drought was achieved with less than 5 %Vol in this layer, there was no difference between the different cover treatments ($p < 0.05$, n = 9-12). In the wet season, until January, the soil water content throughout the soil profile (0-120 cm) of the 500 trees ha^{-1} plots was higher or not different from open grassland plots.





Regarding the RGI, defoliated plants, both at low and high intensity treatments, showed higher RGI than plants without defoliation when growing under both tree canopy cover levels (5.2 to 6.6 vs. 0.8-0.9, $p < 0.05$, n = 3). Low frequency defoliated plants also showed higher RGI than plants without defoliation in all treatments (4.9 to 9.1 vs. 0.8 to 1.3, $p < 0.05$, n =3- 5). In contrast, the RGI of high frequency defoliated plants under tree canopy cover decreased as the number of defoliation events increased. After the third defoliation, defoliated plants under tree canopy cover showed lower RGI than plants without defoliation (see figure above). Tree canopy cover negatively affected the dry matter production of individual grasses compared to those in the open grassland ($p < 0.01$, n = 12-14), regardless of the level of defoliation.

Conclusion

Our results indicate that radiation is more or less limiting than water, in relative terms, depending on defoliation interaction. In this regard, under tree canopy cover the net result of competition and facilitation interactions for plants without defoliation was neutral or negative, while, based on RGI, low frequency defoliated plants showed a net result of interactions neutral or positive compared to plants in the open grassland.