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Impacts of High and Low Blackberry Density on the Vigor of Green Alder at Roan Highlands (North Carolina–Tennessee)

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Abstract

This study focuses on Green Alder (*Alnus crispa*) vigor in relation to high or low Blackberry (*Rubus canadensis*) cover at Roan Highlands along the North Carolina-Tennessee state border. Green Alder has a circumboreal distribution, but the Roan Highlands plants comprise a long-distance disjunct population that is classified as a species of special concern within North Carolina and Tennessee. Green Alders are nitrogen fixers, so it is assumed that they are improving the soil. Blackberries have been invading grassy balds and alder balds at Roan Highlands due to natural succession and are mowed in some areas to manage their population. The hypothesis of the study was that proximity to Green Alder would increase the vigor of Blackberries at Roan Highlands, and that Blackberries would compete with and decrease the vigor of Green Alder. The vigor of Green Alder was quantified by measuring crown loss, new vegetative sprouts, and stem height. Blackberry vigor was quantified by measuring the density and cane height. Results

showed no impact of Green Alder on Blackberry vigor, and little impact of Blackberry cover on Green Alder vigor. However, fewer alders in high Blackberry cover plots produced vegetative sprouts, along with fewer sprouts per clump. Since Green Alder reproduction is mostly clonal, blackberry encroachment could affect its long-term persistence at Roan Highlands.

Introduction

The circumboreal shrub Green Alder (A*lnus alnobetula* ssp. *crispa*, also known as *Alnus crispa)* has a wide range spanning across northern Eurasia and North America (Hantemirova et al. 2023). For such a large range, it doesn't leave a large footprint: “Its entire global range is less than 200 acres" (Schafale 2024). Green Alder occurs in habitats such as floodplain terraces, mountain balds, and tundra valleys (Rhoades et al. 2001). Due to its wide distribution and lack of interbreeding, it has five related subspecies (*A. alnobetula* ssp. *fruticosa, kamtschatica, mandschurica, maximowiczii,* and *sinuata*) (Hantemirova et al. 2023). This study focused data on a disjunct population of *Alnus crispa*, at Roan Highlands on the NC/TN border. The next closest population is found in Pennsylvania, and that one is also disjunct from the more widespread northern range (Schafale 2024). Green Alder primarily reproduces via root sprouts. It also reproduces sexually. Each stem can produce multiple strobiles; our observations show a mean of 159 seeds per strobiles in the Roan Highlands population. Yet it is very rare to find a seedling in the field, since seeds require exposed mineral soil to germinate.

Roan Highlands supports a variety of microhabitats, including high-elevation grassy balds and Green Alder balds (Donaldson et al. 2014). Green Alder has not been observed spreading to other nearby balds within the region, so it’s believed to be restricted to a small area at Roan Highlands. Alders are known to enhance soil fertility by fixing atmospheric nitrogen into the soil (Schafale 2024). This ability may also make the soil conducive to faster-growing plants like the abundant Blackberry (*Rubus canadensis*) that can be found throughout the grassy and alder balds. Blackberry has been encroaching on the balds in recent decades, and sections invaded by Blackberry have shown significantly less herbaceous diversity due to shading by dense Blackberry thickets (Schafale 2024).

There is concern that Blackberry may outcompete Green Alder at Roan Highlands by decreasing its vigor and shading its root sprouts. Blackberries have been managed in the grassy balds with mowing, hand cutting, and goat grazing, but in the alder balds, Blackberries growing very close to the alders cannot be easily managed (Schafale 2024). I hypothesized that Green Alder's ability to fix nitrogen in soil would benefit Blackberry

plants growing in close proximity. I also hypothesized that Blackberries negatively impact alder vigor by shading their stems and root sprouts.

Field Methods

My study was conducted at Roan Highlands during summer 2025; with the help of one field assistant, I collected data from 53 plots on three balds: Round Bald, Jane Bald, and Grassy Ridge Bald. Plots were 5 meters in radius and were established by the Southern Appalachian Highlands Conservancy in 2015 and resurveyed in 2024. Plots were located using GPS and landscape photographs taken at the center of each plot in 2024. We collected data from 27 plots with high Blackberry cover, 16 plots with low Blackberry cover, and 15 plots with no Green Alder. Blackberry cover was based on visual estimates made in each plot in 2024 (Table1). Sample sizes were unequal because most plots in the study area had high Blackberry cover.

In each plot, we measured the height of the tallest live alder stem in one alder clump, and the height of the tallest Blackberry cane that was crowding the alder. We centered a 1-m^2 quadrat around the tallest Blackberry and counted all live Blackberry stems within that quadrat. A visual estimate of alder crown loss was conducted by one field assistant and confirmed by the other, based on these categories: 0-25% loss, 26-50% loss, and >50% loss. We also searched the base of each alder clump and counted new root sprouts without branching; this limited our search to the youngest sprouts.

Statistical methods

Two linear regression models were implemented. One model evaluated the effects of high vs. low Blackberry cover on alder height (alder height was the response variable, and Blackberry cover was a predictor). The other linear regression evaluated whether the presence of alder affected Blackberry height (Blackberry height was the response variable, and alder presence was a predictor). High and low Blackberry cover plots were combined in this analysis. Fisher's Exact Test was used with a 2x3 contingency table to determine whether the three crown loss categories differed in high vs. low Blackberry cover plots. For root sprout data, a Mann-Whitney U test was used to compare the number of sprouts in high vs. low Blackberry cover plots.

Results

The Blackberry cover classification established in the 2024 study was based on visual analysis of each plot (Table 1) used plots in cover calsses1-3 (low cover) and 6-7 (high cover) To limit the number of plots for this study to those experiencing the extremes of Blackberry cover. Alder sprouts were twice as likely to be found in low cover than high cover plots, and four times as many sprouts were found in low cover clumps (Table 2).

Although not statistically significant, the trend found in the moderate crown loss category of Figure 1 suggests Blackberry may be affecting the long-term vigor of Green Alder by reducing the replacement of dead stems. Blackberry height was not significantly impacted by the presence of Green Alder, suggesting that Blackberry growth may not have benefited from nitrogen fixation by Green Alder (Figure 2). In contrast Green Alders were significantly taller when high Blackberry cover plots. This promotes the idea that Green Alder may have been competing for light and grew taller so as not to be shaded out by Blackberry.

Table 1. Cover class categories used to estimate the areal coverage of Blackberry. Low Blackberry cover plots included classes 1-3; high Blackberry cover plots had classes 6 and 7.

Cover Class	Percent Cover
1	**0-1**
2	**1-5**
3`	**5-10**
4	10-25
5	25-50
6	**50-75**
7	**75-100**

Table 2. Mean Green Alder sprout characteristics in high vs. low Blackberry plots. (*P < 0.05)

Variables	Blackberry Cover Class	
	Low	High
Clumps with at least one	56	22
Mean sprouts per clump	2.3*	0.6

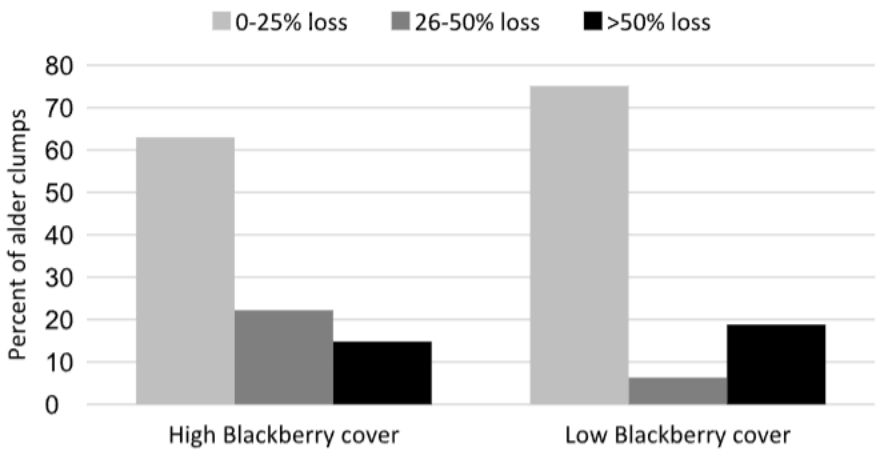

Figure 1. Alder crown loss in high vs. low Blackberry cover plots (Fisher's Exact Test, P=0.518).

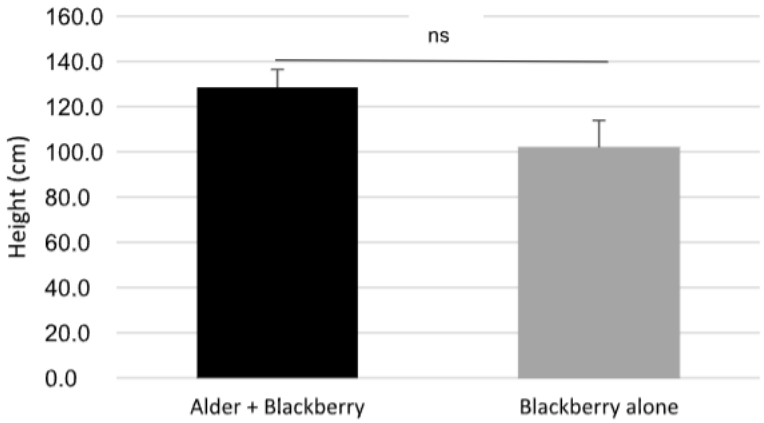

Figure 2. Mean Blackberry cane height for Blackberry alone vs. Blackberry + Alder (ns: P=0.085).

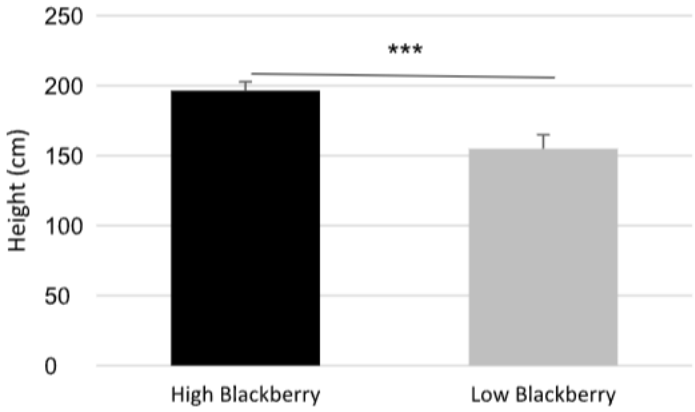

Figure 3. Mean Alder height in high vs. low Blackberry cover plots (*** P<0.001).

Discussion

Blackberry stem density was used to verify the accuracy of the cover classes that were assigned in 2024. My data supported these cover classes (mean blackberry stem density = 26 stems/ m^2 in high Blackberry cover plots, and 6 stems/ m^2 in low cover plots).

Alder clown loss did not differ significantly between high and low Blackberry cover plots (Fisher's Exact Test, P=0.518; Fig1). However, I noticed a trend in the 26-50% crown loss category: 22% of Green Alder clumps fell in this category in the high cover class compared to 6% of clumps in low cover class. This may be the start of a long-term trend of alders beginning to decline in high Blackberry cover plots due to shading and competition. Future research could examine crown loss over a longer period and investigate the age structure of individual clumps. Another sign of potential long-term decline was evident as fewer alder clumps in the high Blackberry cover class produced root sprouts, along with fewer sprouts per clump (Table 2). This is likely due to excessive shading in dense Blackberry thickets.

Blackberry cane height did not differ in high vs. low cover plots (Fig.2), but Green Alder stems were significantly taller in high Blackberry cover plots (Fig.3). These findings suggest Blackberry vigor was not affected by alder presence and may not have benefited from higher soil nitrogen. However Green Alder vigor may have benefited from higher Blackberry cover. One explanation for this is that Green Alder stems in high cover plots may grow taller to avoid being shaded by Blackberries. An alternative explanation is that the high Blackberry cover plots may have been located in more favorable microsites that allowed Green Alder to grow taller while favoring higher levels of Blackberry cover density.

Before Blackberry encroached into the alder balds, Green Alder would have had minimal competition from taller trees and shrubs, which are uncommon in this habitat. I

observed very few places at the study site where alder was in close proximity to plants taller than the Blackberries. This has led me to believe that Green Alders prefer to grow in full-sun conditions. Blackberries also prefer full sun and grow fast and reproduce prolifically, which may have long-term effects on the slower-growing Green Alder. My data show that encroaching Blackberry thickets that shade the base of the alder clumps, outcompete root sprouts for sunlight, negatively affect the persistence of alders in the long term. This is supported by the previously mentioned trend in Figure 1, which suggests some evidence of moderate crown loss in the high Blackberry cover plots. It is also supported by the reduced frequency and number of root sprouts in high Blackberry cover plots.

Conclusion

Green Alders in high Blackberry cover plots had significantly taller stems, perhaps due to competition for light. In contrast, Blackberry height was not significantly affected by the presence of alder and did not appear to benefit from proximity to this nitrogen-fixing shrub. In the short term, Green Alders may be investing more resources in height growth to reduce competition for light, or due to more favorable microsites. However long-term effects of Blackberry encroachment at Roan Highlands could include the decline of alder clumps, as there are fewer root sprouts to replace old branches that die. Blackberries are already managed in the grassy balds with mowers and string trimmers, but these would damage the Green Alders. The safest and most reliable method of managing Blackberries in the alder balds is the practice of hand trimming. Regrettably this is very tedious but remains the safest method for maintaining the integrity of the Green Alder of balds at Roan Highlands.

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