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Leaf chlorophyll levels in green alder and blackberry in a rare plant community: competition or facilitation?

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Abstract

Alnus crispa (green alder) is a nitrogen-fixing, circumboreal shrub distributed throughout Canada and the northeastern United States with disjunct populations in the central and southern Appalachians. In North Carolina and Tennessee, it is classified as a species of special concern that occurs within the globally rare green alder bald community type at high elevations in Roan Highlands. Over recent decades, the alder balds and adjacent grassy balds have been invaded by blackberry (*Rubus* spp.). Blackberry growing near alders could compete for sunlight, nitrogen, and other soil nutrients, which could impact the vigor of the alders and possibly benefit the blackberry. My objective was to better understand how these interactions affected the leaf chlorophyll of blackberry and green alder. Over the summer, we measured leaf chlorophyll of blackberry and alder in low and high blackberry cover plots as well as plots without alder. We measured the height of alder stems and blackberry canes and counted green alder vegetative root sprouts. Linear regression showed that blackberry leaf chlorophyll and height were not significantly

different in plots with and without alder. However, alder leaf chlorophyll and height were significantly greater in plots with high blackberry cover compared to plots with low blackberry cover. This could indicate that alders and blackberries favor certain microsites. In addition, alder in plots with high blackberry cover produced fewer root sprouts (presumably due to excessive shading), which may have long-term consequences for the persistence of green alder at Roan Highlands. Management efforts currently focus on cutting blackberries close to the Appalachian Trail that passes through Roan Highlands, leaving green alder growing away from the trail surrounded by dense thickets of blackberry. We recommend that blackberry management be extended to alder patches downslope and away from the trail, which will involve careful hand clipping to not damage alder stems.

Introduction

Green alder (*Alnus crispa*) is a circumboreal, nitrogen-fixing shrub ranging from the northeastern United States northwards to Canada, though there are disjunct populations in Pennsylvania and at Roan Highlands along the North Carolina/Tennessee state border. The Roan population has been in place since the Pleistocene and forms the unique and globally imperiled green Alder bald community type (Donaldson et al. 2014). This community is characterized by the dominance of green alder with an underlying herbaceous layer of graminoids and forbs (Schafale 2024). Disturbance maintained the integrity of the bald: ancient megafauna grazing during the Pleistocene, then large ruminant animals such as bison, elk, and deer, and finally domestic cattle, which were removed around 1930 when the U.S Forest Service bought the land. Over the last couple of decades limited mowing and weed eating have been conducted in the grassy balds to control woody encroachment. Because disturbance has become less common in the alder balds and adjacent grassy balds, dense thickets of blackberries (*Rubus* spp.) have invaded the alder balds in recent decades, crowding some of the alder clumps.

The roots of green alder are colonized by the nitrogen-fixing bacteria *Frankia*, which increases the availability of exchangeable nitrogen within the soil (Donaldson et al. 2014). It is unclear whether nitrogen-fixing plants benefit neighboring vegetation, though Urli et al. (2020) showed that proximity to green alder (a nitrogen fixer) was positively correlated with increased growth of Jack pine (*Pinus banksiana)* seedlings. Blackberries, which are also a woody species, could respond similarly. At the same time, blackberries could compete with green alder for sunlight and soil nutrients, thereby impacting the vigor and chlorophyll content of the alders. My objectives were to assess the chlorophyll levels of co-occurring blackberries and green alder at Roan Highlands to try to determine whether there were competitive or facilitative effects. I predicted that blackberries would be taller and have higher leaf chlorophyll when near green alders, and that green alders would be shorter and have less leaf chlorophyll when crowded by blackberries.

Materials and methods

We collected data from 5m radius plots at Roan Highlands that were established by Southern Appalachian Highlands Conservancy (SAHC) in 2015 during an initial survey of green alder and blackberry to establish a baseline for green alder and blackberry cover. A follow up survey conducted in 2024 established a cover class system in which the areal coverage of blackberries was visually estimated. Plots with high areal coverage of blackberries were assigned to a high cover class, and plots with low blackberry coverage were assigned to a low cover class.

My study took place during summer 2025. One field assistant helped me collect data in 58 of the SAHC plots. We selected 27 plots with alders and high (≥ 50%) blackberry cover, 16 plots with alders and low (≤ 10%) blackberry cover, and 15 plots with blackberry but no alders. Sample sizes were unequal because most plots were in high blackberry cover classes. We used a GPS to navigate to each plot.

Within plots with alder and blackberry, we identified all alder clumps that were densely crowded by blackberry plants. From those, we randomly chose one green alder clump and measured the height of the tallest alder stem and the tallest blackberry cane. The tallest blackberry cane served as the center of a 1m^2 quadrat, within which we counted the number of live blackberry canes to determine blackberry density. Using a handheld chlorophyll content meter, we measured the chlorophyll content of one leaflet on each of five blackberry canes that were crowding the alder, with all measurements taken from undamaged terminal leaflets. We also measured the chlorophyll content of five undamaged green alder leaves at mid-height on separate non-fruiting stems within the alder clump. For each species, chlorophyll measurements were averaged at the plot level. Results were expressed as CCI (Chlorophyll Content Index), as measured by the chlorophyll meter.

In plots where no green alders were present, we located the tallest blackberry in the plot and measured its height. We then set up a 1m^2 quadrat, using the tallest blackberry cane as the center, and counted the number of live canes within the quadrat. We measured the chlorophyll content of the tallest cane and four additional blackberry canes using the method described above.

Two linear regression models were implemented. One model evaluated the effects of high vs. low blackberry cover on alder chlorophyll (chlorophyll was the response variable and cover category was a fixed effect). The other linear regression evaluated whether the presence of alder affected blackberry chlorophyll (chlorophyll was the response variable and alder presence/absence was a predictor). Plots with high and low blackberry cover were combined in this model. Linear regression was used so that we could include blackberry density as a covariate in both models to account for any effects from interspecific crowding. The number of root sprouts per alder clump was compared for high vs. low blackberry cover plots with a Mann-Whitney U test.

Results

Leaf Chlorophyll

Blackberry leaf chlorophyll did not differ significantly between plots with and without alder (P=0.173; Figure 1). In contrast, alder leaf chlorophyll was significantly higher in high blackberry cover plots compared to low blackberry cover plots (P=0.029; Figure 2).

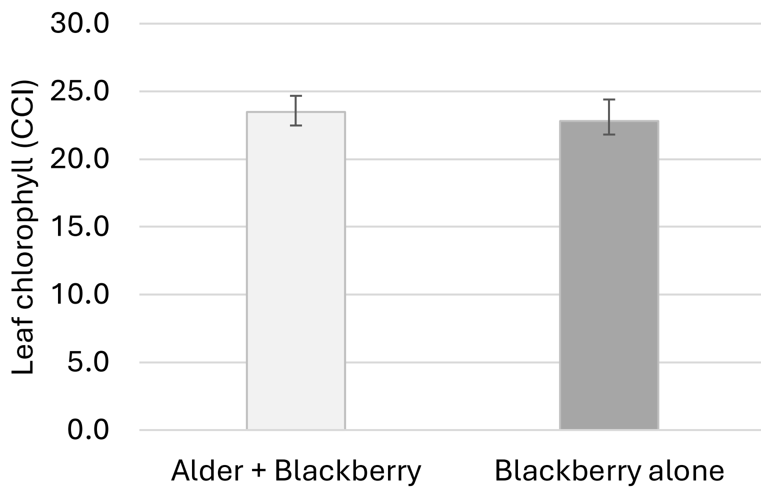

Figure 1. Mean chlorophyll levels (±SE) of blackberry leaves in plots with and without green alder (P = 0.173).

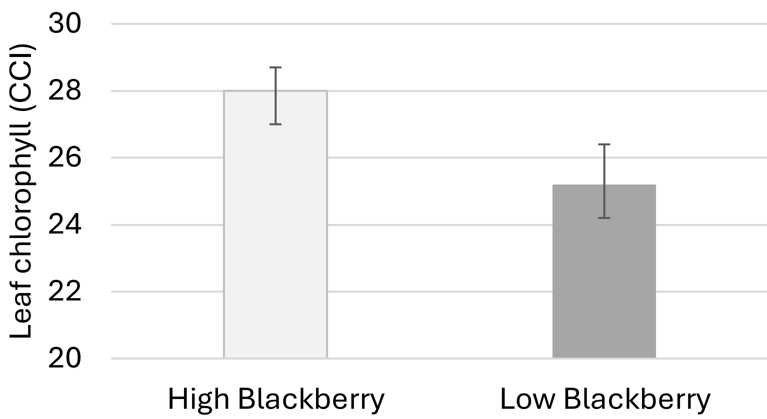

Figure 2. Mean chlorophyll levels (±SE) of green alder leaves in high vs. low blackberry cover plots (P = 0.029).

Height

The height of blackberry canes did not differ significantly in plots with and without green alder (P=0.085), though there was a trend of taller blackberries in plots with alder (Figure 3). In contrast, alders in plots with high blackberry cover were significantly taller than alders in plots with low blackberry cover (P<0.001; Figure 4).

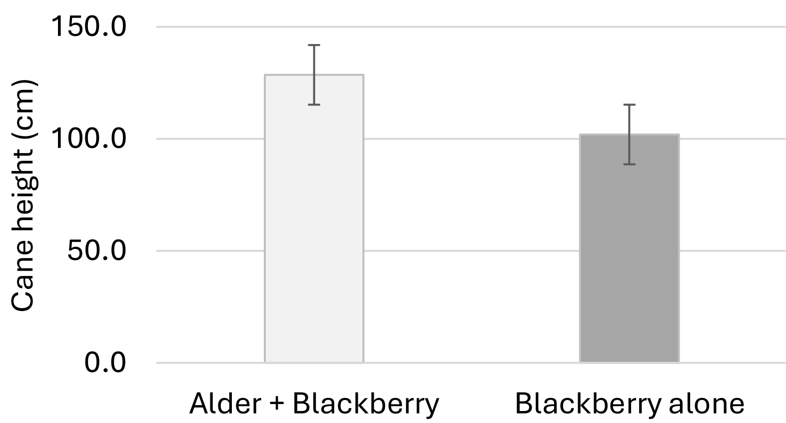

Figure 3. Mean height (±SE) of blackberry canes in plots with and without green alder (P = 0.085).

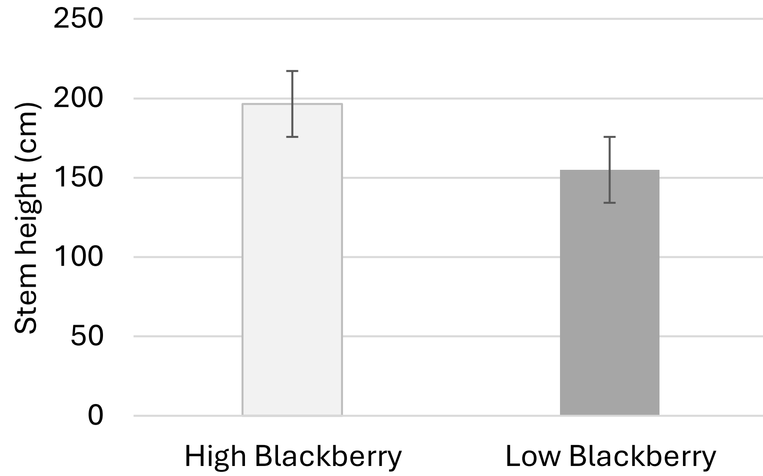

Figure 4. Mean height (±SE) of green alder stems in high vs. low blackberry cover plots (P < 0.001).

Root sprouts

Less than half as many green alder clumps produced root sprouts in high blackberry cover plots compared to low blackberry cover plots (Table 1). In addition, alders in high cover plots had only 26% as many root sprouts per clump, which was a significant difference (P = 0.023).

Table 1. Mean green alder root sprout characteristics in high vs. low blackberry cover plots. (*P=0.023)

	Blackberry cover class		
	Low		High
Clumps with at least one sprout (%)	56		22
Clumps with no sprouts (%)	44		78
No. sprouts per clump	2.3	*	0.6

Discussion

Contrary to my hypothesis, proximity to green alders seemed to have no significant effect on the height or leaf chlorophyll of blackberries. This could be due to green alders at Roan Highlands not releasing enough nitrogen into the soil to significantly benefit the blackberries. It could also reflect our sample size; this would be supported by an apparent trend toward taller blackberry canes in plots with alders (Figure 3). A larger sample size would have given me more insight into this trend.

Alders were significantly taller in plots with high blackberry cover, suggesting that blackberries may not be adversely impacting green alder growth. Many of the high blackberry cover plots were located on slopes off the main ridge in moist microsites that may have been conducive to the growth of both alders and blackberries. In contrast, low blackberry cover plots tended to be located along the ridge, where it was drier and windier. In addition, some of the low blackberry cover plots were near the Appalachian Trail where blackberries could have been mowed or trimmed in past years as part of the grassy bald management effort. This may have affected the vigor of blackberry crowns in those plots. Therefore, environmental conditions could be a stronger influence on alder leaf chlorophyll and stem height than the proximity of blackberries.

Even if blackberries are not affecting the short-term vigor of green alder at Roan Highlands, they could pose long-term consequences for the persistence of the alders. Green alder clumps can be very old but continually renew themselves by producing new vegetative root sprouts. In this way, new stems replace old or damaged growth to keep the genet alive. Compared to low blackberry cover plots, green alders in high blackberry cover plots produced fewer root sprouts, and a lower frequency of alders had any sprouts at all (Table 1). In time, this could result in smaller and/or fewer alder clumps. Future research will focus on the size class distribution of alder stems to determine if there is a difference in overall stem production between alders in high and low blackberry cover, the results of which could be used to predict the future persistence of the alder clumps. SAHC agreed to provide our research team with maps showing where past blackberry management took place in the alder balds, which we can use to see how previous mowing has affected green alder stem size and root sprout production. From our current findings, we recommend that the management of blackberry on the green alder balds be extended to alder patches downslope and away from the trail. This will necessitate labor-intensive hand clipping so as not to damage green alder stems.

Acknowledgements

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References

Donaldson, J. T., Dinkins, Z. C., Levy, F., & Nandi, A. (2014). Surface-soil Properties of Alder Balds with respect to Grassy and Rhododendron Balds on Roan Mountain, North Carolina–Tennessee. *Southeastern Naturalist, 13*(2), 377–395.

Schafale, M. P., (2024). Classification of the natural communities of North Carolina fourth approximation. North Carolina Natural Heritage Program. https://www.ncnhp.org/classification-natural-communities-north-carolina-4th-approximation

Urli, M., N. Thiffault, D. Houle, S. Gauthier, & Y. Bergeron. 2020. Role of green alder in boreal conifer growth: competitor or facilitator? FACETS 5:166-181.