Trico® Deer Browse Repellent Trial at the Holt Research Forest, Arrowsic, Maine

Final Report – October 2022

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Introduction

White-tailed deer pose many threats to forest communities, not only acting as a host for ticks carrying vector-borne diseases that can easily spread to humans (Kugeler et al., 2016; Paddock & Yabsley, 2007) but simultaneously reducing the biodiversity of plant populations through browse (Russell et al., 2001). Importantly, as climate change drives the expansion of white-tailed deer habitats (Dawe & Boutin, 2016), more landowners and forest managers are tasked with finding solutions to protect their forests from browse effects. Red oak is a particularly vulnerable species concerning herbivore browse (Wakeland & Swihart, 2009), and seedlings have been used as indicators of deer browse in published studies (Blossey et al., 2019).

Building large deer fencing structures is time-consuming and expensive. This, coupled with evidence that smaller-scale mesh and fabric seedling sleeves have limited efficacy in red oak protection (Ward et al., 2000), there is a large need for economical and effective means to protect oak regeneration. As such, in this study, we evaluated the effects of a deer browse repellent, Trico® (Kwizda Agro, Vienna, Austria), on red oak seedlings. We compared the effects of deer browse in seedling plots treated with Trico® and compared these to plots established within fenced deer exclosures as well as untreated control plots.

Methods

This study was conducted at the Maine Timber Research and Environmental Education (Maine TREE) property at Holt Research Forest (HRF) in Arrowsic, Maine (43°52'N, -69° 46'W). HRF is a 120-hectare coastal mixed-wood forest dominated by northern red oak (*Quercus rubra*) and eastern white pine (*Pinus strobus*). The study area comprising 60 hectares is divided into a grid system of 0.25-hectare quadrats, subdivided into 0.0625-hectare subquadrats (Figure 1). During the summer of 2021, four 50 × 50 m deer exclosures were erected in four subquadrats, with 2.44 m tall fencing (Figure 2a).

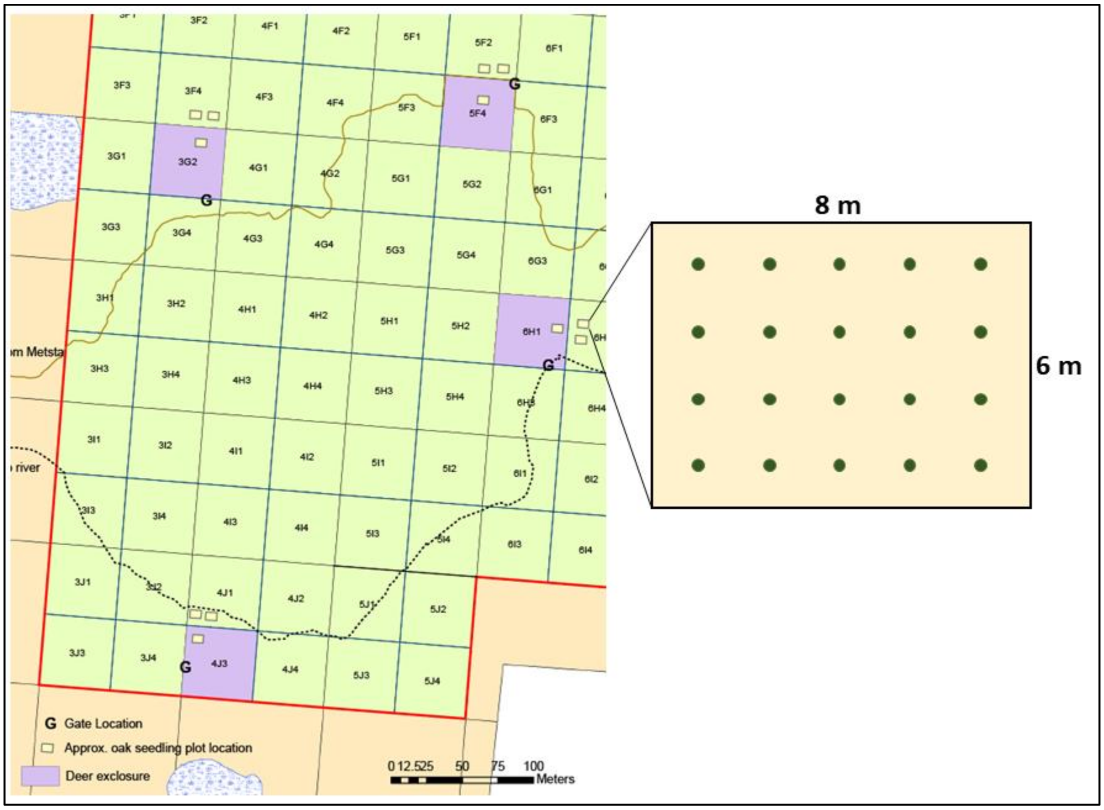

Figure 1. Study site and experimental layout. Left: a schematic showing the grid layout of the Holt Research Forest study area (shown in green), with the four subquadrats encompassing the deer exclosure fencing highlighted in purple. Pale yellow rectangles represent the three treatment plots (control, exclosure, and Trico®) established at each subquadrat. Right: a zoomed-in schematic of one of these treatment plots showing the dimensions and layout of planted seedlings (represented by dark green circles).

At each of the four quadrats, three 6 × 8 m treatment plots were established: exclosure, Trico®, and control (Figure 1, 2b). On October 22, 2021, a total of 240 red oak seedlings (height 6 – 42 cm, Figure 2c) were planted in these twelve plots, 20 seedlings per plot. Trees were transplanted from a local seedling bed within a few miles of the study site. Upon planting, seedlings were labeled with colored pin flags by treatment.

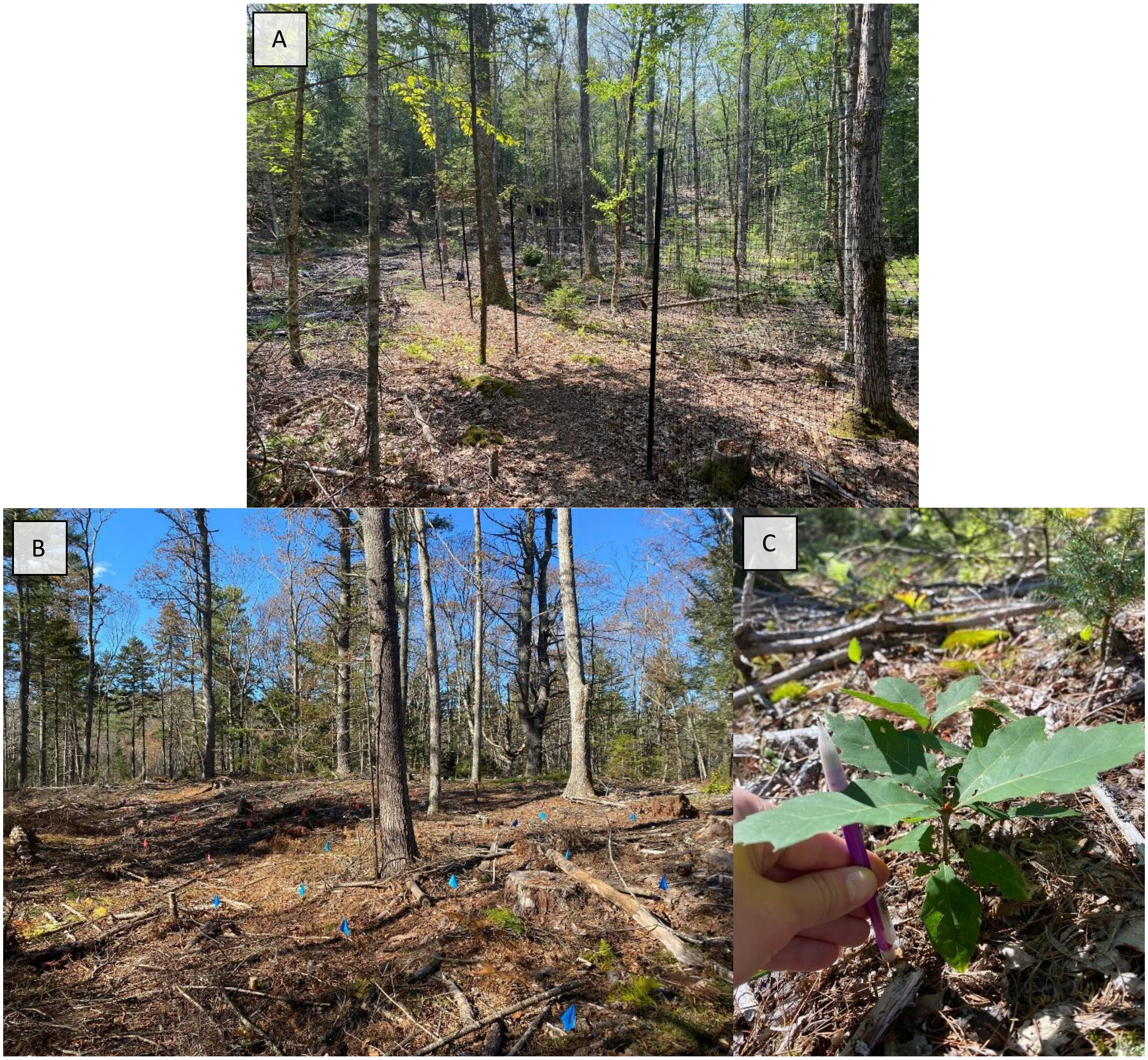

Figure 2. A) Established 50 X 50 m deer exclosure. B) Control (blue pin flags) and Trico® treated (orange pin flags) plots of planted oak seedlings. C) Example of transplanted red oak seedling size.

On November 5, 2021, prior to leaf drop, seedlings in Trico® treatment plots were sprayed with a backpack sprayer (undiluted solution, Figure 3). The exact volume used varied depending on the size of the seedlings but averaged 6.5 ml per seedling. At this time, trail cameras were installed outside the deer exclosures to monitor deer activity in the control and Trico® treated plots throughout the study. On April 22, 2022, before bud break, seedlings in Trico® treatment plots underwent a second full application of Trico® repellent.

Figure 3. Red oak seedling treated with undiluted Trico® prior to leaf drop, November 2021.

In November 2021 and March, June, and July 2022, the HRF research team conducted browse, mortality, and condition assessments on all 240 seedlings. Seedlings were assigned a browse severity score based on the level of damage: 0 = no browse, 1 = seedling-topping, 2 = entire seedling consumed (no evidence of stem remaining) (Table 1). At the end of the experiment, incidence of browse for each seedling was summarized as “browsed” (scores of 1 or 2) or “not browsed” (score of 0) for statistical analysis (Table 1). Condition was summarized as normal and healthy (score of 0) or abnormal (score of 1) for all plants on each measurement date (Table 1). Abnormal condition was defined as any form of leaf discoloration, delayed bud break, or dead areas on the seedling leaves.

Table 1. Score assignments for browse and condition observations in red oak seedlings.

Observation	Score
Browse severity	
No Browse	0
Seedling-topping/leaves partially eaten	1
Entire seedling consumed, no stem remaining	2
Incidence of browse	
Not Browsed	0
Browsed	1
Condition	
Normal/healthy	0
Abnormal	1

At the end of the experiment in July 2022, we used generalized linear mixed effects models (GLMER) to test for the effects of treatment (control, exclosure, Trico®) on our categorical assessments of incidence of browse, condition, and non-browse related mortality. Each model included treatment and quadrat as fixed effects, with a random effect for tree. For the incidence of browse model, we included an additional random effect for the initial tree height. We tested for significant differences between treatments using post hoc Tukey's honest significant tests. All analysis and visualizations were generated using R and the packages "lme4," "multcomp," "ggplot," and "dplyr" (Bates et al., 2015; Hothorn et al., 2008; RStudio Team, 2020; Wickham, 2016; Wickham et al., 2021).

Results:

While we quantified a marginal amount of initial seedling death due to transplantation failure (< 3% total sample size, quantified in November 2021), no browse damage was noticed on red oak seedlings in any of the treatments during the winter of 2021 – 2022. Snowpack may have provided additional protection for these seedlings throughout the winter months, as seedling height averaged 15.3 cm (± 0.39, standard error) and local winter precipitation totaled 9.92 cm from December through February (Prism Climate Group, 2020). Nonetheless, deer did frequent the plots throughout the winter months, as detected by the trail cameras, with the first deer activity witnessed at each subquadrat between November 18 and December 21, 2021.

During the summer of 2022, the red oak seedlings experienced significant impacts of deer browse. Indeed, we quantified deer browse within the fenced exclosures at this time due to windthrow damage that allowed deer and other herbivores into the exclosure areas three times throughout the experiment duration. When assessed at the end of measurements in July 2022, we detected a statistically significant effect of treatment on incidence of deer browse (p = 0.03) that did not differ between quadrats (p = 0.35). Trico®-treated seedlings experienced a significantly reduced total incidence of browse in seedlings (15.9%, Figure 4) compared to control (38.1%) seedlings (p = 0.02). While the incidence of browse was lower in Trico®-treated seedlings than exclosure-grown seedlings (24.2%), the difference between treatments was not statistically significant (p = 0.58). There was no significant difference between exclosure-grown and control-grown seedlings (p = 0.20).

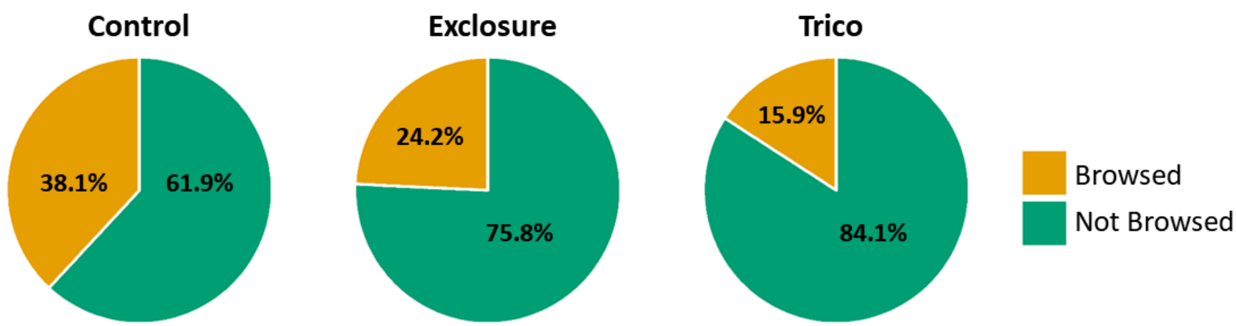

Figure 4. Incidence of deer browse in planted red oak seedlings. Each pie graph represents the total seedling population for each treatment (control, exclosure, and Trico® treated).

We found that only 7.9% of Trico® treated seedlings exhibited severe browse effects, versus control seedlings and exclosure-grown seedlings, which exhibited 15.9% and 23.1%, respectively (Figure 5). Furthermore, Trico® seedlings displayed less moderate browse (7.9%) than control seedlings (22.2%) but slightly more than exclosure-grown seedlings (1.5%, Figure 5).

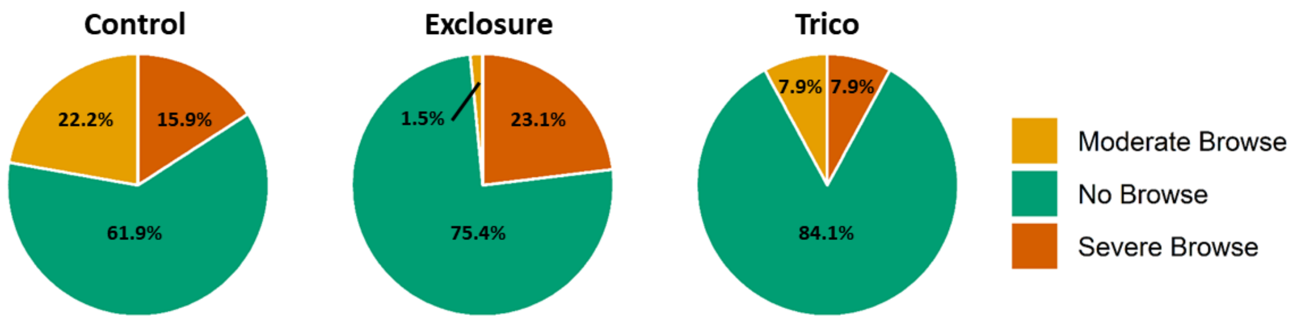

Figure 5. Severity of deer browse in planted red oak seedlings. Each pie graph represents the total seedling population for each treatment (control, exclosure, and Trico® treated).

There was a substantial amount of non-browse-related seedling mortality during the summer of 2022, which was determined by witnessing leaf desiccation and premature leaf shedding. Control and Trico® seedlings experienced 21.3% net mortality, and exclosure trees experienced 17.5%. However, this mortality did not differ significantly between treatments ($p = 0.92$) but did differ between quadrats ($p < 0.01$). Furthermore, during the final assessment at the end of the growing experiment, seedling condition was not significantly impacted by treatment ($p=0.84$) but was significantly impacted by quadrat ($p < 0.01$) likely due to dissimilar environmental conditions.

Discussion

Red oak is a preferred food source for white-tailed deer; indeed, it has been ranked as the most preferred food source over 21 other common tree species, including multiple oak species (Wakeland & Swihart, 2009). As such, successfully regenerating red oak can be challenging when facing increased browse pressure from growing deer populations. Long-lasting and economical browse repellents are therefore needed to protect seedlings prior to forest recruitment.

We found that Trico®-treated seedlings had reduced browse compared to control seedlings and seedlings grown within deer exclosures. Importantly, constructing deer exclosures is a very costly and time-consuming process, with an average price per acre for installation ranging from $446 to $2,400, dependent on the method of installation (Drake & Grande, 2007). Furthermore, we found that the exclosures became damaged and rendered ineffective on several occasions throughout the experiment. Windthrow damage during storms caused the fencing to collapse once during the winter and twice during the spring and summer months, which temporarily allowed browsers into the exclosure plots before exclosure reestablishment.

We believe the damage to the exclosures accounted for some of the browse witnessed in these seedling plots. However, the exclosures are not entirely effective at excluding smaller herbivores that consume seedlings, such as rodents, rabbits, and wild turkeys. Indeed, rodent attack has been witnessed in published browse assessments of red oak seedlings (Blossey et al., 2019). As such, Trico® repellent may prove more successful, long-lasting, and cost-effective while also being less time-consuming compared to traditional deer fencing methods.

Trico® acts by creating both a smell and a taste deterrent, which may lead to increased incidences of only moderate browse witnessed in Trico® plots compared to exclosure plots. In exclosure plots, when game was able to gain access, there was nothing to deter them, which may have led to the higher incidence of severe browse compared to moderate browse (Figure 5).

Importantly, we did not detect a statistically significant impact of treatment on seedling condition. Other deer repellents have caused phytotoxic effects in trees (Bergquist & Örlander, 1996). While we quantified some seedlings with abnormal conditions across all treatments in this study, Trico® did not induce a greater occurrence of this. Since leaf bleaching and spotting was witnessed across control, exclosure grown and Trico®-treated seedlings, we deduced that there was no discernable evidence of phytotoxicity in Trico® plots. As such, our results suggest an additional benefit to Trico® compared to alternative chemical deer repellents.

Interestingly, applying Trico® before bud break decreased deer browse, although the current-year leaves had not yet grown. Future studies should investigate a post-leaf out application to quantify whether this further reduces deer browse in red oak seedlings.

Summary

We quantified substantial deer browse throughout the growing season of 2022. The incidence of browse and severity of browse was less in Trico® treated seedlings compared to control and exclosure-grown seedlings. Furthermore, there was no detectible increase in observed abnormal conditions in Trico®-treated seedlings in this study. Our results suggest that treating red oak seedlings with Trico® in the spring before bud break is effective at reducing deer browse during the growing season for at least 13.5 weeks.

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