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Trico: a novel repellent for preventing deer damage to ornamental shrubs

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Abstract: Homeowners whose landscape plants are repeatedly browsed by white-tailed deer (*Odocoileus virginianus*; deer) desire repellent products that are effective and long-lasting. We conducted a 12-week trial from January 6 through April 5, 2021 to test the duration and efficacy of a novel deer repellent (Trico®) relative to Plantskydd®, a commonly used deer repellent, and untreated plants. We placed treated and control Japanese yew shrubs (*Taxus media 'Hicksii'*) at 4 homeowner sites (Birch Hills Drive, Fairview Crescent, Pinegrove Ave., and St. Paul Blvd.) near Rochester, New York, USA, where we detected deer presence. Yews are frequently eaten by deer during winter and provide a good bioassay for testing repellents. To gauge the efficacy of the repellents, we photographed the yews and scored the level of deer browsing. We used ordinal logistic regression to determine the change in efficacy over time. Trico deer repellent reduced deer damage to yews (chi-square = 97.273, $P < 0.0001$). Damage to yews treated with Plantskydd did not differ from control plants (chi-square = 0.24, $P = 0.621$) after 12 weeks. The performance of deer repellents varied considerably among sites (chi-square = 109.460, $P < 0.0001$). Where there was intense deer browsing pressure (Pinegrove Ave. site), both repellents failed to protect the yews. However, at 3 of 4 sites, the Trico repellent effectively protected yews from deer browsing during winter through spring green-up in April. We found Trico to be an effective, long-lasting repellent for protecting ornamental shrubs from deer browsing during winter.

Key words: human–wildlife conflicts, *Odocoileus virginianus*, ornamentals, New York, repellents, *Taxus media 'Hicksii,'* white-tailed deer, wildlife damage, yews

Browsing damage by white-tailed deer (*Odocoileus virginianus*; deer) to ornamental and garden plants is an important concern for homeowners and landscape professionals (DeNicola et al. 2008, Curtis 2020). As deer populations grow and encroach on suburban development, woody ornamentals suffer browsing damage (Curtis 2020; Figure 1), especially during the winter months when less alternative forage is available. Deer damage to ornamental plants, field crops, nurseries, and orchards causes substantial economic losses throughout much of eastern North America (Drake et al. 2005). Conover (1997) estimated that the economic impacts attributed to deer were $100 million USD and $251 million USD annually for the agriculture and urban sectors, respectively.

Although the market for deer repellents continues to expand, few products have demonstrated effective, long-term protection (Conover 1984, 1987; Lemieux et al. 2000; Ward and Williams 2010). In past field trials, repellents containing putrescent egg solids were most effective, reducing damage by about 50% (El Hani and Conover 1997, Wagner and Nolte 2001). Curtis and Boulanger (2010) found that the best egg-based deer repellents protected Japanese yews (*Taxus* spp.) from deer browsing for about 4–5 weeks during winter in Upstate New York, USA. Freezing temperatures and snow prevent reapplication of deer repellents during winter, so products are needed that reliably repel deer for 3 or more months.

Several commercially available deer repellents contain "natural" active ingredients (a.i.; e.g., putrescent eggs) and are classified as minimum-risk pesticides exempt from Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) registration under Section 25(b). Consequently, many repellent products have not been tested in controlled, replicated trials. We evaluated a novel deer repellent (Trico®, Kwizda-Agro Gmbh, Vienna, Austria) formulated from "sheep fat" (6.4% a.i.) that was developed in Europe to protect trees from deer browsing. Palmer (2017) reported an "excellent

Figure 1. White-tailed deer (*Odocoileus virginianus*) feeding on yew plants (*Taxus media 'Hicksii'*) at the Pinegrove Ave. site near Rochester, New York, USA, during January 2021 (*photo courtesy of Cornell University Deer Research Program*).

performance history" for this deer repellent in northern Europe. Trico was registered in 2021 as a deer repellent in New York (Environmental Protection Agency [EPA] Reg. No. 71637-2) and 13 other states (Colorado, Georgia, Kansas, Maine, Minnesota, New Jersey, Oklahoma, Oregon, Pennsylvania, Tennessee, Texas, Vermont, and Washington, USA).

Fat-based products are known to repel deer, as the commercial product Hinder® (EPA Reg. No. 8119-8; Mattson, LLC., North Bend, Washington) contains "ammonium soaps of higher fatty acids" (0.66% a.i.). Fargione and Richmond (1991) reported that tallow fatty-acid soaps reduced deer damage significantly more than coconut fatty soaps and that tallow appeared to be a major component responsible for soap's deer repellent properties. We compared the relative effectiveness of Trico to Plantskydd® (HPI Products Inc., St. Joseph, Missouri, USA). Plantskydd is commonly used as a deer repellent, contains the natural ingredient "dried blood" (84.5% a.i.), and is exempt from EPA registration under FIFRA Section 25(b) guidelines.

Deer prefer yews as forage during winter (Conover and Kania 1988, Curtis and Boulanger 2010), and consequently, yews provide a good bioassay for comparing the efficacy of repellents. Previous studies that evaluated the effectiveness of deer repellents occurred in nurseries (Conover 1984, Lemieux et al. 2000) or with captive deer (Andelt et al. 1991, 1994; Kimball et al. 2005, 2009). These controlled studies may not represent what would happen with natural deer herds in a typical suburban home site where deer have free choice for browsing. Our objective was to evaluate the relative deer repellency of Trico and Plantskydd repellents for protecting yews from deer browsing under conditions commonly experienced in homeowner landscapes.

Study area

We selected 4 test locations near Rochester, New York (Figure 2), in suburban lawn areas (345 Birch Hills Drive [Lat. 43.23523, Long. -77.55017], 69 Fairview Crescent [Lat. 43.22355, Long. -77.60112], 551 Pinegrove Ave. [Lat. 43.22916, Long. -77.58519], and 2449 St. Paul Blvd. [Lat. 43.20162, Long. -77.61920]) to conduct our research. We selected the sites because landowners had previously reported deer damage, and there were visible signs of current deer activity. The sites were located >2 km apart so that different family groups of deer would be responsible for plant damage at each site. In exurban Maryland, USA, family groups of deer had small home ranges (70.9–144.0 ha, 95% adaptive kernel area) and resided in similar locations throughout the year (Rhoads et al. 2010).

The daily temperatures during the field trials in January through April 2021 ranged from a low of -16.7°C (2°F) in February to a maximum of 26.1°C (79°F) in April at the Greater Rochester International Weather Station (Lat. 43.1172, Long. -77.6754; Northeast Regional Climate Center 2021). Snow accumulations were 55.6, 75.9, 3.6, and 11.9 cm for January, February, March, and April, respectively. There was less snowfall in March 2021 than a normal year (45.5 cm). Snowfall during the other months was similar to long-term averages. Overall, 147.1 cm (57.9 inches) of snow accumulated during January through April 2021 compared to 181.4 cm (71.4 inches) during a normal year.

Methods

Late winter to early spring is the optimal time to conduct experimental trials with yew shrubs because fresh green vegetation is not yet sprouting, and deer are seeking quality forage, especially during times with deep snow (Curtis and Boulanger 2010). We sprayed our study plants with repellents before placing them into the field to allow consistent and thorough application of

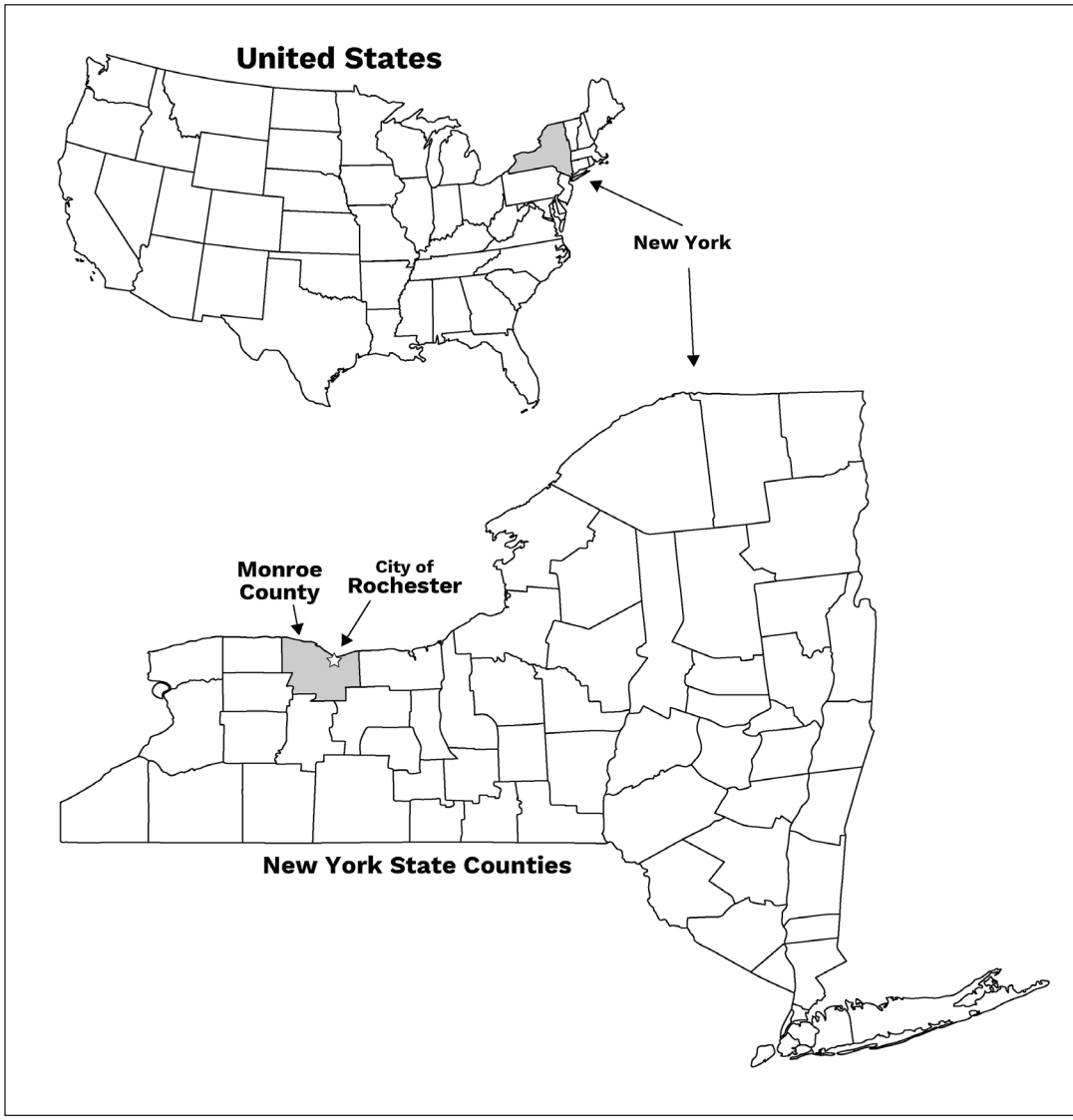

Figure 2. Location of study sites near Rochester in Monroe County, New York, USA.

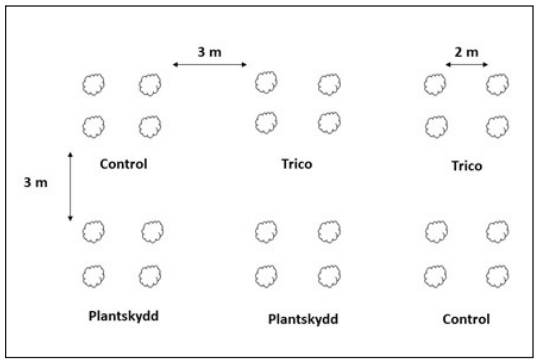

Figure 3. Randomized layout for yew plants (*Taxus media 'Hicksii'*) at the St. Paul Blvd. site near Rochester, New York, USA.

all repellents on dry foliage. Yews were sprayed outdoors at ambient temperature using a backpack sprayer (Model 430-1G, Solo Corp., Newport News, Virginia, USA) until the drip point. The Trico repellent was applied undiluted, and all growing points of each tree were sprayed. The amount per tree varied depending upon the size of the tree. The yews were left to dry for 24 hours before being placed in a fenced area outdoors to protect them from deer damage.

Japanese yews with root systems balled and covered in burlap were transported into backyards of cooperating landowners during the weeks of January 6 (Birch Hill Drive and St. Paul

Figure 4. Yew plants (*Taxus media 'Hicksii'*) from field sites near Rochester, New York, USA, on April 5, 2021, showing relative levels of white-tailed deer (*Odocoileus virginianus*) browsing. Browse ratings were 0 = no damage, 1 = 1–20% limbs browsed, 2 = 21–40% limbs browsed, 3 = 41–60% limbs browsed, 4 = 61–80% limbs browsed, and 5 = >80% limbs browsed (*photos courtesy of M. Ashdown*).

Blvd. sites) and January 14 (Fairview Crescent and Pinegrove Ave.). We placed yews at each site where we saw evidence of recent deer activity (e.g., deer trails, tracks in the snow, or deer droppings). Plants were placed 2 m apart within rows (Figure 3) with at least 3 m between treatment blocks. Two replicates of 3 treatments (2 repellent formulations plus control) were randomly assigned to 4 yews in a block (8 yews per treatment, 24 total shrubs at each site).

Baseline photographs were taken of all yews during week 0 (January 6 or 14, 2021) on the first day the yews were placed into the field. Photographs were repeated on April 5 at the conclusion of the 12-week field trial. Although we visited sites once during February to check the status of plants, we only recorded damage scores at the end of the trial. Photographs were taken with a digital camera (Nikon Coolpix 8700, Nikon Inc., Melville, New York). We used a white board as a background for reference photographs, and each plant was labeled. We also maintained a consistent distance from the yew shrub to the camera of 2 m with a string tied to the white board, and a tripod was used to keep the camera at the same height above the ground for all photographs.

We scored deer damage to the yews with a visual rating system (Figure 4) based on the total percent of limbs browsed on each shrub (0 = no damage, 1 = 1–20% of limbs browsed, 2 = 21–40% of limbs browsed, 3 = 41–60% of limbs browsed, 4 = 61–80% of limbs browsed, and 5 = >80% of limbs browsed). The same person (co-author Eshenaur) scored the deer damage to each of the yews at all 4 sites to maintain consistency. Because the number of stem tips on each yew was too high to reliably count, we looked at the crown surface of the shrub and estimated the percentage of stem tips browsed (Figure 4). Because damage ratings were not continuous or normally distributed, we used ordinal logistic regression to model damage intensity on browsed yew shrubs by treatment and site. Analysis was performed using JMP Pro version 14.0.0 (SAS Institute Inc., Cary, North Carolina, USA).

Results

Deer had browsed the control yews at all 4 sites before 12 weeks, and most shrubs were scored a 5 (>80% of stems browsed; Figure 4). Deer browsing scores were lower for shrubs treated with the Trico repellent than control yews (chi-square = 25.93, $P < 0.0001$; Figure 5). However, the damage scores observed for yews treated with Plantskydd did not differ

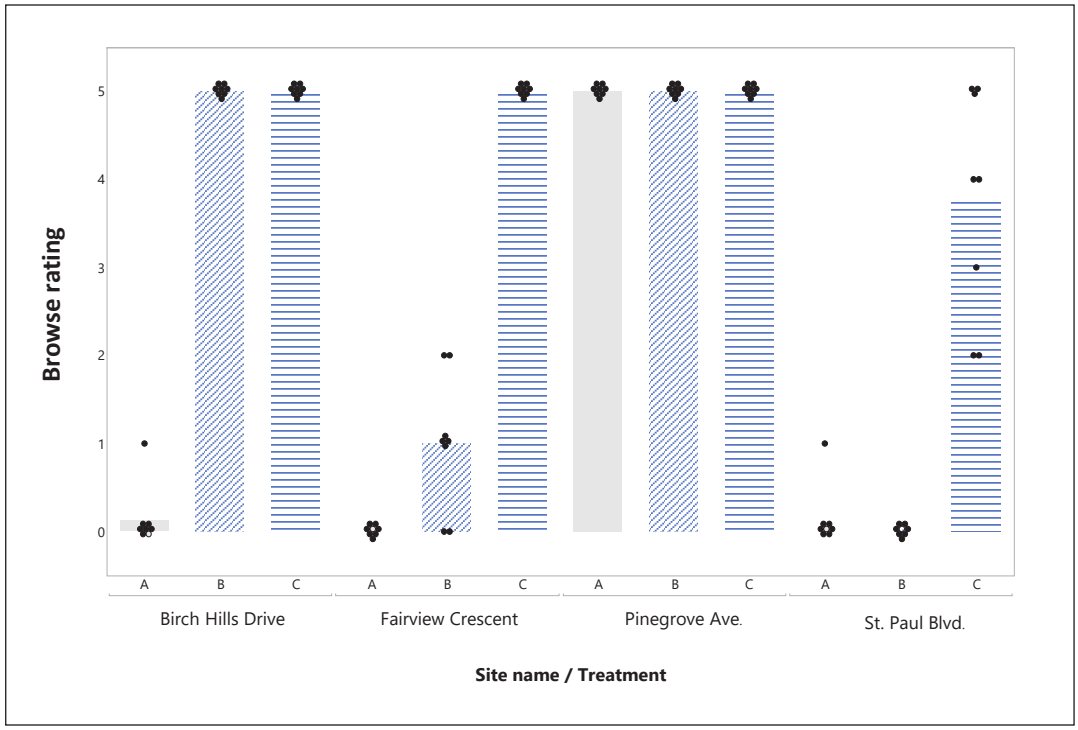

Figure 5. Damage ratings for white-tailed deer (*Odocoileus virginianus*) browsing on yews (*Taxus media 'Hicksii'*) by treatment and site, January to April 2021 near Rochester, New York, USA. Repellent treatments included: A = Trico®, B = Plantskydd®, and C = control. Black dots are scores for individual yews, and the bars represent average scores for each treatment.

from control yews (chi-square = 0.24, $P = 0.62$). Trico effectively protected 24 of 32 (75%) treated yews at 3 of 4 sites. By February 4, after 3 weeks, control yews and those treated with Plantskydd were already heavily damaged (damage scores of 5) at the Pinegrove site. Yews treated with Trico lasted a few days longer but were severely browsed by February 7.

There were differences in deer browsing pressure between sites (chi-square = 109.46, $P < 0.0001$). The St. Paul Blvd. location had the lowest damage levels, as only 1 treated yew was browsed by deer (Figure 5). The Pinegrove Ave. site had the highest deer browsing pressure, and all yews (both treated and control) were severely damaged before April 5, 2021. Deer browsing pressure at the Fairview Crescent and Birch Hills Drive sites was intermediate between the St. Paul Blvd. and Pinegrove Ave. locations (Figure 5).

No phytotoxicity was observed following the repellent treatments. The taxus foliage on all the plants remained healthy for the duration of the study, except for those yews damaged by deer browsing.

Discussion

Long-lasting repellent products are critically needed to protect ornamental shrubs from deer browsing, especially during winter when snow limits alternative forage available. In past winter field trials with treated yews, deer avoided repellents containing putrescent egg solids for up to 6 weeks, and other repellents tested failed after 4–5 weeks (Curtis and Boulanger 2010). Trico deer repellent has a distinct advantage over other commercial products by providing longer duration protection. During winter, deer browsing on yew shrubs was reduced for at least 12 weeks at 3 of 4 sites with moderate to heavy deer browsing pressure. Consequently, a single treatment of Trico repellent in late fall or early winter could protect ornamental shrubs until spring green-up when deer reduce feeding on woody landscape plants. This could offer a practical alternative to expensive deer fencing needed to protect ornamentals and crops (Curtis et al. 1994).

Deer repellents cannot be applied when there are freezing temperatures or if plants are covered by snow or ice. This has limited potential

repellent applications during winter months in the northern United States and Canada. We initially treated our test yews outdoors during January with above-freezing temperatures and let the repellents dry thoroughly before moving plants to our field sites. This should not have impacted the effectiveness of the repellents tested and ensured the products would adhere well to the foliage.

Ease of use is an important factor when selecting deer repellents. The pre-mixed Trico repellent was simple to use, and we had no problems spraying this repellent on the yews. We found the Plantskydd powder concentrate difficult to mix and spray on treated shrubs. The powder concentrate must be mixed slowly with water to prevent foaming, then it was filtered to prevent clumping and clogging the sprayer nozzle. This would likely be a deterrent for use by most homeowners. Big Game Repellent® powdered concentrate containing putrescent egg solids was also difficult to apply in past deer repellent studies (Curtis and Boulanger 2010).

Environmental factors influence the relative effectiveness of deer repellents. Variables such as deer density, snow depth and duration, alternative forage available, plant palatability, and deer body condition (e.g., fat reserves) make it difficult to predict deer browsing pressure at a given site *a priori*. In theory, repellents work by reducing the palatability of treated plants relative to other available forage (El Hani and Conover 1997, Curtis and Boulanger 2010). It is much more difficult to protect highly preferred winter shrubs such as yews, especially when persistent snow cover reduces the alternative forage available.

Management implications

Effective and longer-lasting repellents are needed to reduce deer browsing damage to ornamental plants. The new Trico deer repellent, containing sheep fat as the active ingredient, protected yews (a preferred winter forage) for at least 12 weeks at 3 of 4 sites in central New York state during winter when deer were food-stressed by snow and cold temperatures. The Trico product out-performed Plantskydd, a commonly used deer repellent. During previous studies, even the best deer repellents failed after 6 weeks when tested under similar winter conditions with high deer-browsing pressure. It may be possible to protect ornamentals for the entire winter season with a single spray application of Trico during late November or early December.

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