Final Report for 23-02-CAES, "Comparison of long-lasting deer repellents"

Richard S. Cowles, Ph.D.

Connecticut Agricultural Experiment Station, Valley Laboratory, Windsor, CT

Technical Report

Abstract

A field trial comprised of three replicates and three treatments in a randomized complete block design was conducted to compare the efficacy of Trico Pro deer repellent with a formulation planned for marketing under the trade name "No-Does". Soybean plots (6 x 6 and 8 x 8 meters) at the C.A.E.S. Valley Laboratory farm established close to the field/forest interface were heavily fed upon by deer. Deer browsed up to the edge of the repellent-treated plots, and made foraging incursions into two of the three untreated check replicates, as well as into one of the plots treated with Trico Pro. The lack of browsing in one entire replicate (attributable to satiation), including the untreated check required non-parametric comparison of browsing in the two remaining replicates. The proportion of plants with feeding injury significantly differed between all three treatment groups. The untreated control group, Trico Pro, and No-Does are listed in order of decreasing browse activity, as determined with Fisher's Exact Test procedure, with each group being statistically different from the other two. There was no deer browsing within the plots treated with the No-Does formulation during the 12 weeks following a single foliar spray application. A second field trial was conducted during the winter of 2023 to 2024, with potted taxus shrubs placed under a powerline right of way where deer were accustomed to feed during the growing season in food plots. Three deer repellents were compared with an untreated control group in a randomized complete block design with nine replicates. Shrubs were sprayed on December 7, 2027 and placed in square plots, 4 m apart to prevent odor interactions between treatments. Treatments were Trico Pro, No-Does, and a 1:1 dilution of Half-&-Half (milk and cream, containing emulsified animal fats). At the conclusion of the trial on April 19, 2024, all the untreated check plants had evidence of feeding by deer, whereas none of plants treated with any of the three candidate deer repellent materials exhibited any damage.

Background

Deer browse on agricultural crops, landscape plantings, and seedlings or transplants in a forest causes significant economic losses. The recent introduction of the Trico and Trico Pro products, based on a stable emulsion of the body fat of sheep, provides long-lasting protection of plant material from feeding by deer. This is an expensive product, and so a less costly alternative was investigated based on ingredients that are exempt from U.S. EPA pesticide registration via Section 25(b) rules. The resulting product contains water, lanolin, sodium lauryl sulfate, and small quantities of two preservatives, sodium benzoate and potassium sorbate. This formulation is planned for marketing under the trade name "No-Does," and is readily manufactured as a 10X concentrate. A direct comparison of the Trico Pro product, No-Does, and similar fat-based deer repellents will allow farmers, landscape maintenance companies, and homeowners to make informed decisions regarding the effectiveness of these products.

Methods and Materials

Part I. Growing season comparison of deer repellents

Plot establishment protocol. A field at the Valley Laboratory was prepared for planting soybeans by spreading 600 lb per acre of pelletized limestone on 8 March, 2023, and then plowed and disked on 12 April. Soybeans of the cultivar "Large Lad" which is a Roundup Ready forage type, was drilled on 15 June at the recommended rate of 1 bag (140,000 seeds) per acre into the approximately 0.15 acre field. On 28 June, the approximately 60 x 100-foot area was enclosed with 7.5-foot-tall plastic mesh fence to exclude deer until the plants had grown enough to start the repellent experiment. The perimeter fence was removed from its original location on 20 July and reused to enclose a single 10 x 24-meter rectangular deer exclusion area in the center along the west edge of the field. On 20 July plots were laid out and sprayed with deer repellents (see below). The entire area of soybeans was sprayed on 21 July with Mikaze (glyphosate) at the 2% spray concentration, requiring 5 gallons of spray to treat the field.

Experiment set-up. Three replicates of plots were established surrounding three sides of the fenced deer exclusion area at the west edge of the field. Three treatments were included in a randomized complete block design. The replicate along the east side of the physical deer exclusion fence was composed of three 8 x 8-meter plots, in which the the north and south edges of this replicate were aligned with the north and south edges of the deer exclusion fence. One replicate on the south and one on the north side had 6 x 6-meter plots. These plots extended far enough beyond the east side of the deer exclusion area to match the east edge of the east replicate, so that the entire area for the experiment including the physical deer exclusion section was a rectangular area of 24 x 36 meters.

Products used in this experiment were Trico Pro, containing 6.4% body fat of sheep, and No-Does, in which the 10X concentrate product contains lanolin, water, and sodium lauryl sulfate. Commercial No-Does will include 0.05% each of sodium benzoate and potassium sorbate as preservatives, but the formulation used in this experiment was freshly made just prior to application and preservatives were not included. The remaining treatment was an unsprayed control. The application method for both products followed the guidelines on the Trico Pro label, targeting an application rate of 2.2 gallons per acre. This translated to a volume of 74 mL and 132 mL of product (undiluted for Trico Pro, diluted to 5% lanolin content for the No-Does treatment) being sprayed in the 6 x 6-meter and 8 x 8-meter plots, respectively. This was accomplished with a CO_2-pressurized research sprayer set to 20 p.s.i., with a wand equipped with an 8002 flat fan nozzle. The small spray volume required spraying each plot very quickly to deliver the product within the treated area.

Plots were examined routinely to evaluate whether deer browsing had occurred. On 17 August, feeding had occurred in the south and east replicates, but not in the north replicate. Data were collected by examining plants for signs of feeding. Twenty-five plants from each of four quadrants within each plot were examined for damage and the total for each plot calculated. Because there was no feeding in the north replicate, Fisher's Exact test was applied to the damaged/undamaged plant totals combined from the two replicates where feeding had occurred to determine if there were statistical differences between treatments. On 10 October, a single east-west transect measured plant height through the center of the plots on the south side of the experiment and to the field edge. The first sample was taken within the first plot, one meter from the west edge of the plot. Each succeeding sample was spaced at a 2-meter interval, and so there were three plants sampled in each of the treatment groups. Plant height was defined as the distance from the ground to the base of the petiole of the highest leaf on the plant.

Results

Feeding was observed in two of the untreated check plots and one of the Trico Pro-treated plots. The pattern of feeding observed on 17 August continued throughout the experiment, until the first freeze in October. Fisher's Exact test revealed that there were statistical differences between all three treatments, with the greatest amount of feeding in the untreated check group (74 browsed, 126 not browsed), the Trico Pro treated plants (51 browsed, 149 not browsed), and the No-Does treated plants (0 browsed, 200 not browsed). Statistical significance was $P = 0.0175$ for the comparison between the untreated check and Trico Pro, and $P < 0.0001$ for the comparison between the Trico Pro and the No-Does groups.

Deer satiety probably influenced the results from this experiment. Because the field had an irregular shape on the east side, to fit a rectangular area into the planted field the treatment plots were not positioned at the edge of the field closest to the woods. There was a gradient of browse damage observed in this field (Fig 1). The height of the plants increased as the distance from the edge of the field increased. Therefore, the distance of the experimental plots from the edge of the field and the extraordinary nutritional value of this forage soybean may have decreased the risk of feeding within our plots. This obviously influenced the results from the north replicate, where there was no feeding within the plots throughout the duration of the experiment (12 weeks). However, there was feeding within two of the three untreated check plots, and browse damage to one of the Trico-Pro treated plots. Furthermore, there was browse activity up to the edge of the repellent-treated plots, which became obvious as the height of the soybeans precipitously dropped at the edge of the plot (Fig. 2). The No-Does treatment influenced feeding behavior of deer at a distance. This is evident from the height of the soybean plants rapidly decreasing for about 3 – 4 meters from the edge of the plot (Fig. 1), as well as within the untreated check plot in the experiment (Fig. 1), in which there was less feeding than was expected. Note that no area of the untreated check plot represented in Figure 1 was more than 3 meters from plants sprayed with either Trico Pro or No-Does. Furthermore, the soybean plants were about 30 cm tall at the time they were sprayed, yet the ultimate height of the plants was about 145 cm by 10 October, meaning that the residues were more than 1 meter distant from foliage at the tops of the treated plants.

Part II. Protection from winter feeding by deer

Experiment set-up. Yew shrubs are notoriously attractive to deer during the winter. Thirty-six small *Taxus* shrubs in 2-gallon nursery containers were treated with 5.0 mL of repellents each, using a fingertip spray atomizer (ULINE Model S-24562C). Previous calibration demonstrated that 34 pumps would deliver 5.0 mL of product. Products tested were Trico Pro, No-Does, and Half-&-Half (Hood Corp.), which is an emulsified mixture of milkfats. Pots were marked on one side with a white paint pen, to allow "before" and "after" photographs to be properly aligned (Fig. 3).

Pots were spaced in a square grid, 4 m apart within plots, and with nine replicates. The location was under a powerline right of way where deer were accustomed to feed during the summer and fall seasons in food plots consisting of soybeans, sunflowers, and other preferred annuals. Shrubs were sprayed on December 7, 2023 and placed into the plots after the spray had dried.

Results

Plants were observed on Jan. 5, 11, and 18, Feb. 7 and 23, and March 14 for evidence of deer browsing.

		Number of plants with deer feeding (out of nine replicates)			
Date	Treatment:	Untreated	Trico Pro	No-Does	Half-&-Half
Jan. 5		2	0	0	0
Jan. 11		3	0	0	0
Jan. 18		7	0	0	0
Feb. 7		8	0	0	0
Feb. 23		8	0	0	0
Mar. 14		9	0	0	0

Each of the deer repellents was statistically repellent to deer, relative to the untreated check, $P < 0.0001$, Fisher's exact test.

Conclusion

For the summer trial of repellents both the Trico Pro and the No-Does repellents were effective. Soybeans treated with the No-Does product were not damaged for 12 weeks (the duration of the experiment) following a single spray application when the soybeans were about 1-foot tall.

For the winter deer repellent trial, all three repellents, including Half-&-Half, were effective for the entire five-month period of observation.

Including the Half-&-Half product in the winter comparison demonstrated the principle that animal fats, and not specifically body fat of sheep are highly repellent to deer. A deer repellent based on lanolin has advantages of being exempt from U.S. EPA registration and since it is food approved and hypoallergenic is suitable for use up do the day of harvest on edible crops. It is inexpensive and can be manufactured by growers for their own use at a cost of about $10 per acre. However, lanolin is difficult to clean completely from sprayers and must be ordered from bulk suppliers over the internet. A repellent based on milk fat has the advantage of being available from grocery stores and is already a stable, sprayable emulsion when purchased as milk or cream. It isn't suitable for use on edible crops, because consumers may be allergic to ingested dairy products. For Christmas tree growers, a milk fat-based deer repellent may be a convenient deer repellent. At a final spray concentration of 5% fats and using 2 gallons of spray to treat an acre, deer repellents based on milk fat and lanolin will have similar material cost to growers.

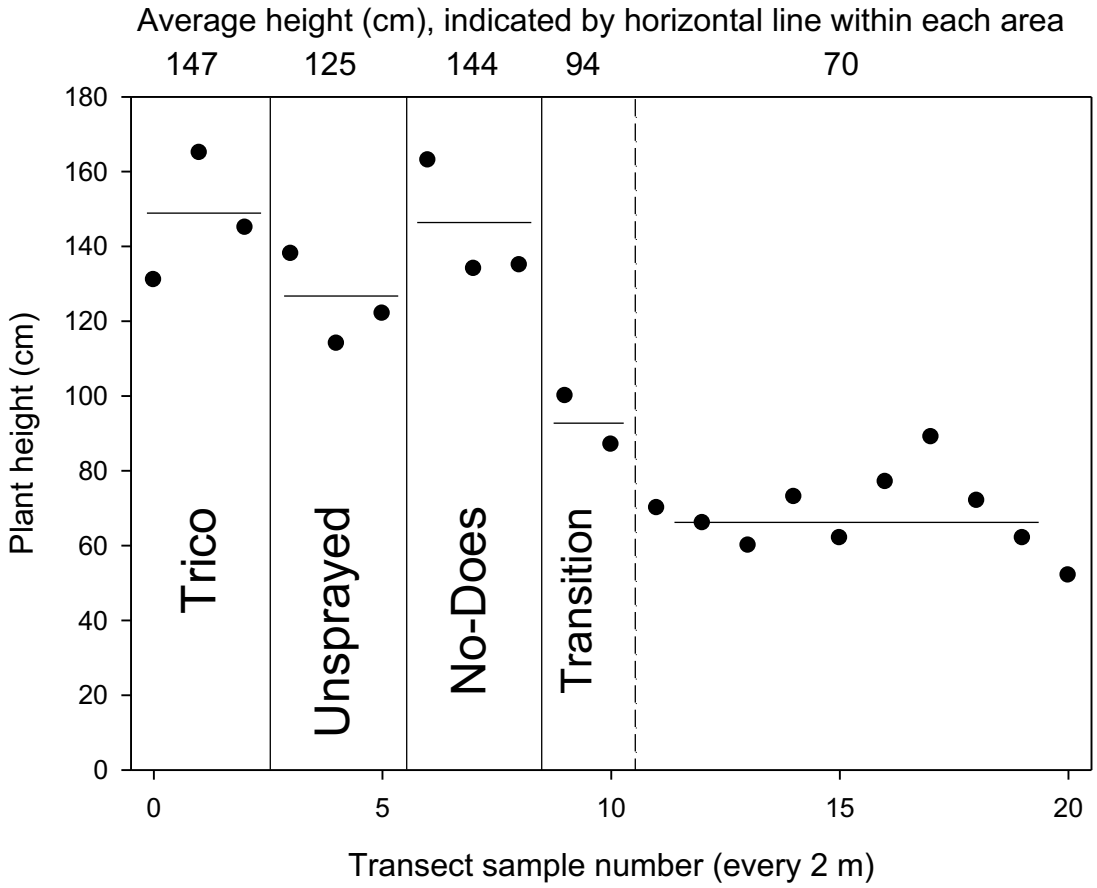

Figure 1. Plant height (cm) measured in a transect through the center of the south replicate of treatments. Vertical lines represent the plot boundaries, with the dashed vertical line representing the estimated edge of the observed influence on deer browsing behavior outside of the treated plots. Transect Sample #20 was at the edge of the field closest to the woods.

Figure 2. The height of soybeans in the experimental plots (at the right side of the photo) dropped off dramatically at the edge of the No-Does treated plots (just to right of the center of the photo) and decreased like a ramp for approximately 3 – 4 meters outside of the plots, to the position where the laboratory technician (6 feet tall) is standing. The orientation of this image is reversed from the transect measurements in Fig. 1 (the edge of the field towards the woods is to the left of the edge of this photograph). The photograph was taken on 20 September, 2023, after some lodging of the very tall plants had occurred. Plants within the treated plots reached the center of the chest, or twice the height of the soybeans unprotected from the effects of the deer repellent.

Figure 3. Two representative replicates of yew shrubs subjected to winter browse damage by deer, with “before” photos taken Dec. 7, 2023 and “after” photos taken April 19, 2024.

Summary of Research Report for Public Release

Deer repellents of the past have involved products that are toxic, malodorous, or must be reapplied too frequently to be practical. An exceptional alternative for Christmas tree growers has been the Trico Pro product, manufactured by Kwizda, a company in Austria that uses the body fat of sheep as the active ingredient. This product has been demonstrated to provide winter-long protection against deer browsing in Christmas trees. At a cost of $90 - $180 per acre to apply this product, Trico Pro is expensive. Alternatives to Trico Pro, based upon sprayable emulsions of animal fats and related molecules, have been developed and tested to determine whether they can provide the same level and duration of protection as Trico Pro. A lanolin emulsion in a product that will be marketed as No-Does was found to be equivalent to or superior to Trico Pro when tested during the summer to protect soybeans from deer browsing. The recipe allowing Christmas tree growers to make an equivalent lanolin-based product for use on their own farms has been freely shared at meetings and through state Christmas tree growers' newsletters (CT and VT/NH). The deer repellent using this recipe costs no more than $10 per acre for the ingredients. An alternative deer repellent based upon milkfat was found to be equivalent to Trico Pro and the No-Does. Its advantage is that the ingredient is available at grocery stores and the sprayer is easily cleaned after application. All three repellents provided protection from feeding by deer through the winter.