Reducing Deer Damage to Woody and Herbaceous Plants

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ABSTRACT

Woody and herbaceous plants in urban and rural landscapes , nurseries, orchards, and Christmas tree plantations are becoming increasingly susceptible to deer feeding damage. The first set of trials presented four plant species treated with Deer-Away®, Hinder® (1:20), Tree Guard®, Milorganite® fertilizer, chicken eggs, chicken eggs with Tree Guard, and chicken eggs with Transfilm, to captive white-tailed deer *(Odocoileus virginianus)*. Only chicken eggs alone and Deer-Away deterred deer from feeding on the containerized nursery stock. Chicken eggs alone was more effective than Deer-Away. In a second trial, paired comparisons were made with Deer-Away and Hinder (1:1 and 1:5), Tree Guard, Miller Hot Sauce® Animal Repellent (0.62% and 6.2%), and two experimental predator urines ("A" and "B"). Pellet/corn deer food was treated and presented to captive deer. Consumption of food treated with both rates of Miller Hot Sauce and Predator Urine "A" was significantly less than Deer-Away treated food. Consumption of Hinder 1:1 and Predator Urine "B" treated food was similar to Deer-Away treated food. Consumption of Hinder 1:5 and Tree Guard treated food was significantly greater than Deer-Away treated food. In the third and fourth trials, Deer-Away, Hinder 1:1, Tree Guard, Miller Hot Sauce (0.62% and 6.2%), and Predator Urines "A" and "B" were applied to pellet/corn deer food and presented to captive deer and free-ranging deer at three independent sites. In the third trial, deer consumed the smallest quantities of food treated with 6.2% Miller Hot Sauce and Predator Urine "A" and consumed the greatest quantities of food treated with Tree Guard. In the fourth trial, deer consumed the smallest quantities of food treated with 6.2% Miller Hot Sauce, Hinder (1:1) and Deer-Away, and deer consumed the greatest quantities of the control and Tree Guard treated food.

KEY WORDS

chicken eggs, deer, Deer-Away, Hinder, Hot Sauce, Milorganite, Minnesota, repellents, Tree Guard, urine

INTRODUCTION

White-tailed deer browse on a variety of nursery crops, orchards, Christmas tree plantations, and home landscapes. Substantial economic losses occur, especially during the winter months, when natural food supplies are limited. White-tailed deer are particularly capable of surviving in urban, suburban, and rural areas and have become a significant threat to landscapes and horticultural production systems. Commercial deer repellents are at times the only possible solution for reducing deer browsing, as fencing can be costly and aesthetically undesirable.

Several repellents have been tested and confirmed to reduce deer feeding. Deer-Away (37% putrescent whole egg solids) and Hinder (15% ammonium soaps of higher fatty acids) have been shown to be effective in reducing food consumption by captive mule deer (Andelt et al. 1991) and free-ranging deer (Conover 1987). Milorganite fertilizer (composted sewage sludge) has been reported to have some repelling qualities. Two concentrations of Miller Hot Sauce Animal Repellent (2.5% capsaicin) reduced the feeding of captive mule deer on apple twigs (Andelt et al. 1994). Coyote urine reduced browsing by deer on woody plants (Sullivan et al. 1985, Swihart et al. 1991). NorTech Forest Products, Inc. has proposed that their bitter taste product, Tree Guard (0.2% denatonium benzoate), may provide some long-term protection from deer feeding activities (Tree Guard product label). Whole chicken eggs mixed with water and foliarly applied reduced deer damage to soybean fields (Manning 1982).

Our objectives were to compare the relative effectiveness of Deer-Away, Hinder, Milorganite, Tree Guard, Miller Hot Sauce Animal Repellent, whole chicken eggs, and two predator urines for reducing white-tailed deer feeding on landscape plants.

METHODS AND STUDY AREAS

Phase 1

Five trials were conducted between June 29 and October 5, 1994. Repellents were applied to red-osier dogwood *(Cornus sericea)*, PeeGee hydrangea *(Hydrangea paniculata* "Grandiflora"), day lily *(Hemerocallis fulva)*, and Royal Standard hosta *(Hosta* x "Royal Standard"), four plant species determined in previous testing to be highly preferred by the captive deer. Each trial contained two or more treatments from those listed in Table 1. During each trial, treatments were replicated five times. Five treatment blocks were placed 10 m apart, and plants within blocks were placed 3 m apart. The location was a 1-ha site containing 20 captive white-tailed deer in Dayton, MN. The deer were permitted to roam freely throughout the enclosed site. During each trial, the liquid repellents were sprayed onto the plants outside of the enclosed site using a nitrogen pressurized backpack sprayer. Chicken egg mixtures consisted of blending the eggs (without shells) with 240 ml of water, added to 3.78 L of water, Tree Guard, or Transfilm mix. Granular Milorganite fertilizer was uniformly distributed over the container substrate surface. When liquid repellents had dried on the foliage, the plants were arranged in a randomized complete block design. The number of terminal growing points of each plant was

Table 1. Deer Repellent Products Used During Phase 1 To Treat Red-Osier Dogwood, PeeGee Hydrangea, Day Lily, and Royal Standard Hosta in Minnesota From June Through October 1994

Treatment	Rate
Deer-Away	As per label[1]
Hinder	1:20 Hinder:Water
Tree Guard	Applied as formulated
Milorganite fertilizer	227 g/plant
Chicken eggs	3 eggs/3.78 L water
Chicken eggs	8 eggs/3.78 L water
Chicken eggs	3 eggs/3.78 L Tree Guard
Chicken eggs	8 eggs/3.78 L Tree Guard
Chicken eggs + Transfilm	3 eggs/3.78 L water + Transfilm mix (4:1 water:Transfilm)
Chicken eggs + Transfilm	8 eggs/3.78 L water + Transfilm mix (4:1 water:Transfilm)
Control	Untreated

[1] As per label 1:1:6 (Formula 2104:Concentrate 2103:Water)

recorded prior to the deer having access to the plants. Feeding damage was evaluated every 24 hr by counting the number of terminal growing points browsed.

Phase 2

Two trials were conducted between November 13, 1994, and February 25, 1995, offering a commercial pellet/corn deer food (Heim Milling Co., St. Cloud, MN) to white-tailed deer at the same location as described in Phase 1. Treatments were applied by placing the food in a fine mesh strainer, then dipping the strainer into the liquid repellent. Food was immersed in the liquid for approximately 1 sec, and the strainer was quickly twisted to ensure that the food did not simply float on top of the liquid, but rather was totally immersed in the repellent. The food was then thinly spread on fine mesh screening and allowed to dry for 12 hr. Treated food was presented to the deer in 7.56 L plastic containers. Treatments were randomized and placed 3 m apart. Repellent efficacy was determined by the volume of treated food consumed each day.

Treated food was presented to the deer at the same time each morning. The containers were weighed using a digital scale prior to the deer having access to the food. When all deer had eaten from the containers and walked away from the treatment site, the containers were again weighed. The deer were then allowed at their leisure throughout the day to eat from the

containers. At the same time each day, before sunset, the containers were again weighed. Containers and food were then removed from the pen.

Treatments were presented every other day. Untreated food was offered ad libitum on days between treatments. This helped to maintain the deer in a similar nutritional status for all treatment days. On those days when untreated food was offered, the food was presented to the deer and removed from the pen at the same times of day as when treated food was offered.

The first trial tested the efficacy of seven repellents compared to Deer-Away by using paired comparisons between Deer-Away and two concentrations of Hinder (1:1 and 1:5), Tree Guard, Predator Urines "A" and "B," and two concentrations of Miller Hot Sauce (0.62% and 6.2%) from November 22, 1994, through January 14, 1995. Of the 10 deer present at the enclosed 1-ha site, 1 deer had previously experienced repellents. Deer-Away was mixed at the labeled recommended rate of 1:1:6 (Formula 2104:Concentrate 2103:Water). Two concentrations of Hinder were prepared by mixing 1 part Hinder to 1 part water (1:1), and 1 part Hinder to 5 parts water (1:5). Tree Guard and Predator Urines "A" and "B" were applied as formulated. Miller Hot Sauce was mixed at 10 times the labeled concentration (0.62%), and 100 times the labeled concentration (6.2%). Vapor Guard®, an antitranspirant, was added at a 0.5% concentration to both Hot Sauce solutions (as per label instructions). From November 13 through 21, an acclimation period allowed the deer to adapt to the new food and method of eating from plastic containers. The acclimation period was ended when the daily total amount consumed was consistent over a 3-day period. This signified the amount that satiated the deer, and the amount that would be presented each treatment day. Except Deer-Away, which was present every treatment day, the seven treatments were each replicated on 3 random days over a 6-week period. On each treatment day, 10 subsamples of each treatment were offered. Ten subsamples helped to ensure that many deer had exposure to each treatment.

The second trial tested the efficacy of Deer-Away, Hinder (1:1), Tree Guard, Predator Urines "A" and "B," and two concentrations of Miller Hot Sauce (0.62% and 6.2%) from February 17 through February 25, 1995. Of the 15 deer present at the enclosed 1-ha site, 10 had previously experienced repellents. Deer-Away was mixed at the labeled recommended rate of 1:1:6 (Formula 2104:Concentrate 2103:Water). Hinder was prepared by mixing one part Hinder to one part water (1:1). Tree Guard and Predator Urines "A" and "B" were applied as formulated. Miller Hot Sauce was mixed at 10 times the labeled concentration (0.62%) and 100 times the labeled concentration (6.2%). Vapor Guard, an antitranspirant, was added at a 0.5% concentration to both Hot Sauce solutions (as per label instructions). Treatments were randomized and replicated over 5 days, one every other day. On each treatment day, four subsamples of each treatment were offered. This helped to ensure that many deer had exposure to each treatment.

Phase 3

This trial compared the efficacy of Deer-Away, Hinder (1:1), Tree Guard, Predator Urines "A" and "B," and two concentrations of Miller Hot Sauce (0.62% and 6.2%) against untreated controls on three separate wild deer populations between March 14, 1995, and March 27, 1995. Repellents were mixed in the same manner as in Phase 2. The three sites were investigated as

to their deer populations via helicopter overhead views and extensive ground scouting. Fourteen deer were observed at Site No. 1, 20 deer at Site No. 2, and 6 deer at Site No. 3. Treatments were applied to the pellet/corn food in the same manner as in Phase 2. Food was presented in black plastic 10-cm high containers placed 3 m apart on each side of a major deer trail at each site. Food was placed at the sites 1 hr before sunset, and the food was removed the following morning 1 hr after sunrise. An acclimation period offering untreated food ad libitum from March 2 through March 13 allowed the deer to adapt to the new food and to eating from plastic containers.

Treatments were replicated over 5 days, one every other day. On each treatment day, four subsamples of each treatment were offered, which helped to ensure that many deer had exposure to each treatment. Repellent efficacy was measured by the volume of treated food consumed each night. Untreated food was offered ad libitum on days between treatments.

RESULTS

Phase 1

Three chicken eggs/3.78 L of water proved to be the most effective deer repellent (Table 2). Deer avoided feeding on these treated plants for 3 to 4 days and only began feeding on them when all untreated and less effective repellent-treated plants were completely browsed. Increased concentrations of eggs (8 eggs/3.78 L water) did not increase the repellency. Anticipating that

Table 2. Terminals Browsed (%) During Phase 1 of Red-Osier Dogwood, PeeGee Hydrangea, Day Lily, and Royal Standard Hosta by Captive Deer 1, 2, 3, and 4 Days After Treatment (DAT) in Minnesota From June Through October 1994

Treatment	1 DAT	2 DAT	3 DAT	4 DAT
Hinder 1:20	100	100	100	100
Deer-Away	0	50	100	100
Tree Guard	100	100	100	100
Milorganite Fertilizer	100	100	100	100
Chicken Eggs (3)	0	0	50	100
Chicken Eggs (8)	0	20	70	100
Chicken Eggs (3) + Tree Guard	0	50	100	100
Chicken Eggs (8) + Tree Guard	100	100	100	100
Chicken Eggs (3) + Transfilm	10	80	100	100
Chicken Eggs (8) + Transfilm	100	100	100	100

an egg mixture would not remain on the foliage through heavy rains, Transfilm and Tree Guard were added to the egg mixture in an attempt to increase longevity. Both products contain compounds that adhere the liquid to the foliage. These mixtures were not as effective as eggs in water alone. Transfilm and Tree Guard appeared to mask the smell of the eggs, even when 8 eggs/3.78 L of water were used. Deer-Away provided limited effectiveness. Milorganite fertilizer, Tree Guard, and Hinder (1:20) were completely ineffective.

Phase 2

In the first trial, average consumption of deer food varied between repellent treatments when compared to Deer-Away (Table 3). Consumption of food treated with both rates of Miller Hot Sauce and Predator Urine "A" was significantly less than Deer-Away treated food. Consumption of Hinder 1:1 and Predator Urine "B" treated food was similar to Deer-Away treated food. Consumption of Hinder 1:5 and Tree Guard treated food was significantly greater than Deer-Away treated food. Deer-Away was present each day that a trial was performed. As expected, consumption of Deer-Away treated food increased as the deer were continually exposed.

In the second trial, average consumption of deer food varied among repellent treatments (Table 4). Deer consumed the smallest quantities of food treated with 6.2% Miller Hot Sauce and Predator Urine "A," and they consumed the greatest quantities of food treated with Tree Guard. Of the 15 deer present, 10 had experienced the treatments in the first trial. It is theorized that those 10 deer accustomed to Deer-Away were responsible for the high consumption of Deer-Away treated food.

Phase 3

Average consumption of deer food varied among repellent treatments (Table 5). Deer consumed the smallest quantities of food treated with 6.2% Miller Hot Sauce, Hinder (1:1), and Deer-Away, and consumed the greatest quantities of the control and Tree Guard treated food. Feeding results for Site No. 3 were not analyzed as deer presence was inconsistent. On most treatment days, there was no consumption of untreated or treated food at this site.

DISCUSSION

Deer-Away is considered by researchers to be the most consistently effective deer repellent. Based on our results, there may be other effective repellents available.

During trials with captive deer and nursery plants, three chicken eggs per gallon of water was the most effective repellent. However, during application, this substance quickly clogged the screen of the sprayer nozzle. In addition, it is doubtful that this substance would persist through rains.

Miller Hot Sauce 6.2% and 0.62% were in certain trials more effective than Deer-Away and, in other trials, equal to or nearly as effective as Deer-Away. These results are similar to another experiment that showed that these increased product rates were effective in reducing feeding of

Table 3. **Average Daily Deer Food Consumption[1] (g) During Phase 2, Trial 1 by 10 Captive Deer in Minnesota From November 1994 Through January 1995**

Treatment	Mean Consumption
Deer-Away	3374 a[1]
Miller Hot Sauce (6.2%)	244 b
Deer-Away	3567 a
Predator Urine "A"	1163 b
Deer-Away	2889 a
Miller Hot Sauce (0.62%)	545 b
Deer-Away	2912 a
Hinder (1:1)	2656 a
Deer-Away	1897 a
Predator Urine "B"	1866 a
Deer-Away	2303 b
Hinder (1:5)	3165 a
Deer-Away	2208 b
Tree-Guard	4067 a

[1] Each treatment consisted of 4,800 g of deer food.

[2] Within each comparison, means followed by the same letter are not significantly different ($P = 0.05$) based on a paired t-test.

Table 4. Average Daily Deer Food Consumption[1] (g) During Phase 2, Trial 2 by 15 Captive Deer in Minnesota During February 1995

Treatment	Mean Consumption
Miller Hot Sauce (6.2%)	105.20 a[2]
Predator Urine "A"	284.80 a
Miller Hot Sauce (0.62%)	521.60 b
Hinder (1:1)	896.80 c
Predator Urine "B"	1214.40 d
Deer-Away	1393.40 d
Tree Guard	1698.00 e

[1] Each treatment consisted of 1,920 g of treated food.

[2] Means followed by the same letter are not significantly different ($P = 0.05$) based on Duncan's multiple range test.

Table 5. Average Daily Deer Food Consumption (g) During Phase 3 by Free-Ranging Deer at Two Sites in Minnesota During March 1995

Treatment	Site #1[1] Mean Consumption	Site #2[2] Mean Consumption
Hinder (1:1)	41.00 a[3]	322.00 a
Miller Hot Sauce (6.2%)	48.40 a	173.60 a
Deer-Away	66.00 a	334.00 a
Predator Urine "A"	164.00 b	1138.80 b
Miller Hot Sauce (0.62%)	312.80 c	1690.00 c
Predator Urine "B"	335.20 c	1815.60 c
Tree Guard	615.60 d	2373.20 d
Control	907.20 e	2720.00 e

[1] Each treatment consisted of 912 g of treated food.

[2] Each treatment consisted of 2,720 g of treated food.

[3] Means followed by the same letter are not significantly different ($P = 0.05$) based on Duncan's multiple range test.

captive mule deer on apple branches (Andelt et al. 1994). Increased concentrations of Miller Hot Sauce (6.2% and 11.5%) were shown to be nonphytotoxic to apple trees in another experiment (Andelt et al. 1992). Currently, the increased rates of 6.2% and 0.62% are experimental only. However, the manufacturer (Miller Chemical and Fertilizer Co.) is investigating registering the Hot Sauce product at the increased rates of 0.62% and 6.2% Hot Sauce.

Hinder 1:1 proved to be an effective repellent. Label directions allow for the use of Hinder 1:1, but phytotoxic results on plants during the growing season may result. When applied to buttonbush *(Cephalanthus occidentalis)* plants placed in full sun, we observed severe burning of the leaves. This rate of Hinder would be best used on dormant plants.

Predator Urine "A" is from a feline species. Predator Urine "B" is from a canine species. In general, Predator Urine "A" was more effective than "B." In their present undiluted form, both urines are suspected to cause phytotoxic damage to young plant growth during the growing season. In addition, neither product currently contains a sticking agent, and it is theorized that the urines would not persist during rains. The manufacturer plans to continue research with both products, investigating dilution rates and the addition of sticking agents.

Tree Guard was the most ineffective of all treatments. Two Tree Guard formulations were tested. The first was the currently commercially available formulation. The second was an experimental formulation from the manufacturer. Both formulations exhibited similar results. In the past, other experiments have tested denatonium benzoate, the active ingredient in Tree Guard. At concentrations similar to or greater than those found in Tree Guard, denatonium benzoate did not prove to be an effective repellent. There is little evidence to support claims that bitter taste substances deter herbivores. It should never be assumed that chemical compounds which are unbearably bitter to humans are therefore deterrents to herbivore feeding. Current research has proven that taste receptors in animals are different than those in humans.

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