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Screening of Odor and Taste Repellents for Control of White-tailed Deer Browse to Apples or Apple Shoots[1]

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Abstract

A rapid method was developed for evaluating deer repellents using apples or apple shoots were placed on 1 m (3.3 ft) stakes in a highly populated white-tailed deer area. Big Game Repellent (BGR, Putrescent whole egg solids (37%)), Hot Sauce (Capsaicin (2.5%)), and Lifebouy soap (scented or unscented) were the most effective repellents, but they repelled deer for only very short periods of time (1 to 6 days). The perfume from Lifebuoy soap also showed some repellency. Dilution of any of the repellents reduced their effectiveness for inhibiting deer browse. Deer readily accepted apples placed on stakes, but they would not touch broccoli heads.

Index Words: White-tailed deer, *Odocoileus virginianus*, Boddaert

Significance to the Nursery Industry

Bar soap is currently being used to repell low and medium deer populations from young apple trees. Our data indicate that soap chips (no perfume) were as effective for repelling deer as the perfume or the combination of soap + the perfume. Highly desirable food materials (apples or apple shoots) at this highly populated deer test site, could not be protected from deer browse for more that 1 to 3 days.

Introduction

Deer browse damage to fruit trees and nursery crops has been recognized as a serious problem, particularly during orchard and nursery establishment (1, 2, 5, 6, 7). Young or dwarf trees are particularly susceptible to damage since the plants are at an ideal height for browsing (2, 6). Any damage to the central leader or the 4–5 lower scaffolds in the first to third years can seriously affect the structure and bearing capacity of the tree. Fencing which is expensive has been the most "fool-proof" method for eliminating deer damage under high deer pressure (2). In areas with moderate to low deer pressure, various repellents have been used with success (2, 4, 5), but they are usually short-lived, require repeated application, and are variable in effectiveness. Odor repellents placed in apple trees are more desirable than taste repellents since they may inhibit both feeding and antler rubbing. A taste repellent would not be expected to reduce antler damage.

To further evaluate observations made by growers and university researchers, several experiments were conducted to determine the effectiveness of Lifebuoy soap ingredients and other repellents for deer repellency (3).

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Materials and Methods

Several experiments were conducted at the National Zoological Park, Smithsonian Institute, Front Royal, VA, in a 50 Ha (124 A) field and timber area. Apples or apple shoots were placed on 1 m (3.3 ft) stakes for periods from 0 to 6 days. Before starting each apple experiment, apples were placed on the stakes to ensure deer were visiting all of the areas. Apples were placed on nails that were driven into the top of the stakes.

Apple shoots were prepared by cutting the vegetative apple shoot 50 to 100 cm (20 to 40 in) in length and placing in water in a plastic 0.5 1 (0.13 gal) container wired to each stake.

Each experimental plot consisted of 6 stakes placed in a row at 3 m (3.3 ft) intervals and was located at least 30 m (33 ft) from any other plot. One plot represented a replicate. The forty (40) plots were blocked into 4 groups of 10. The experimental design was a randomized complete block. Ten treatments or less were run at one time. One block was located in an open area, another in a low area near a pond, and two blocks were located along gravel roads leading into wooded areas. Apples or apple shoots placed on the stakes were examined after 1, 2, 3, and 6 days for feeding unless otherwise indicated. Repellents tested are listed in Table 1.

Statistical analyses were performed using SAS GLM procedures (SAS Institute) (8). Each treatment was compared to the control by Chi Square (9) for experiments 1, 2, 3, 4, 5, 6, 7, 8, and 9. Duncan's multiple range test (9) used for treatment separation for experiments 10 and 11.

Experiment 1. On April 2, 1987, 60 'Golden Delicious' apples and 60 broccoli heads were placed on stakes and observed after 24 hours to determine which plant material might be most attractive. The cut end of the broccoli heads was placed in bags of water and wired to the stake. One apple was placed on a nail on the top of each stake.

Experiment 2. On July 28, 1987, 24 apples of the following treatments—20% Thiram (tetramethylthiram disulfide (65%); 100% Hinder (mixture of fatty alcohols (C_8 = 42%; C_{10} = 56%) (85% ai); or untreated control—were dipped for 5 seconds and one apple was placed on each

Table 1. White-tailed deer repellents tested.

Trade name	Active ingredient (%)	Source
Big Game Repellent	Putrescent whole egg solids (37%)	Deer-A-Way Flora & Fanua Lab, Inc.
Hot Sauce Animal Repellent	Capsaicin (2.5%)	Miller Chemical and Fertilizer Corp.
Lifebuoy bar soap	unknown	Lever Brothers Co.
Lifebuoy soap chips (no perfume)	unknown	Lever Brothers Co.
Lifebuoy perfume	unknown	Lever Brothers Co.
Hinder Deer and Rabbit Repellent	ammonium soaps of higher fatty acids (15%)	Leffingwell Chemical Co.
Thiram 65WP	tetramethylthiram (65%) disulfide	FMC Corp.
Off-Shoot T	Mixture of fatty alcohols (C_8 = 42%; C_{10} = 56%) (85% ai)	Proctor and Gamble
Bubble gum flavor	unknown	Miller Chemical and Fertilizer Corp.
Baby powder fragrance	unknown	Miller Chemical and Fertilizer Corp.
Diallyl sulfide	Diallyl sulfide	ICN K & K Laboratories, Inc.
Piperine	Piperin (20%)	ICN Pharmaceutical
Broccoli extract	unknown (762 g (1.7 lb) ground in 500 ml methanol and evaporated to 100 ml methanol)	
Pine Sol	unknown	American Cyanamid
Tree paint	unknown	Associated Technical Consultants
ICI L-22	unknown	ICI Americas, Inc.
Dried cabbage	unknown	
Cedar leaf oil	unknown (75%)	ICI Americas, Inc.
Vapor Gard	di-1-p-menthene (96%)	Miller Chemical and Fertilizer Corp.
Deer Blood	unknown	Fresh killed

stake in the experimental design as described above (6 apples/rep and 4 reps/treatment).

Experiment 3. On July 30, 1987, 24 apples of the following treatments—100% Hot Sauce; 100% Off Shoot T; 100% Lifebuoy perfume or a untreated control—were dipped for 5 seconds and one apple was placed on each stake in the experimental design as described above (6 apples/rep and 4 reps/treatment).

Experiment 4. On August 4, 1987, 24 apples of the following treatments—100% Hinder; 100% Hot Sauce; 25% Hot sauce; 10% Hot sauce; 100% Lifebuoy perfume; 100% Bubble gum flavor; 100% Baby powder fragrance; 100% Broccoli extract; or a untreated control—were dipped for 5 seconds and apple was one placed on each stake in the experimental design as described above (6 apples/rep and 4 reps/treatment).

Experiment 5. On August 28, 1987, 24 apples of the following treatments—100% Hot Sauce; 100% Diallyl sulfide; 5% v/w piperine (1 g piperine/5 ml acetone + 20 ml ethanol)—were dipped for 5 seconds and one apple was placed on each stake in the experimental design as described above (6 apples/rep and 4 reps/treatment).

Experiment 6. On July 7, 1987, one vegetative apple shoot of each of the following treatments—25% Lifebuoy perfume in tree paint applied to shoot stem; ½ bar Lifebuoy soap tied on the stake; or untreated shoots—was placed on each of 24 stakes in the experimental design as described above (6 shoots/rep and 4 reps/treatment).

Experiment 7. On July 28, 1987, one shoot of each of the following treatments—½ bar Lifebuoy soap tied on the stake; 3.5 g (0.12 oz) Tree paint painted on tape and placed on the stake; 0.9 g (0.03 oz) Lifebuoy perfume in 3.5 g (0.12 oz) Tree paint painted on tape and placed on the stake; 150 g (5.3 oz) Lifebuoy soap chips (no perfume) in cheese cloth bag and tied on stakes; 1% Baby powder + 1% hot sauce sprayed on shoots; 0.5% Hot Sauce sprayed on shoots; 1% Lifebuoy perfume sprayed on shoots; 4% Pine Sol sprayed on shoots; or untreated shoots—was placed on each of 24 stakes in the experimental design as described above (6 shoots/rep and 4 reps/treatment).

Experiment 8. On July 21, 1987, one vegetative apple shoot of each of the following treatments—1% Baby powder + 1% hot sauce sprayed on shoots; 0.5% Hot Sauce sprayed on shoots; 1% Lifebuoy perfume sprayed on shoots; 1% Off Shoot T sprayed on shoots; 5% Thiram sprayed on shoots; or untreated shoots—was placed on each of 24 stakes in the experimental design as described above (6 shoots/rep and 4 reps/treatment).

Experiment 9. On August 11, 1987, one vegetative apple shoot of each of the following treatments—Lifebuoy perfume soaked in a cheese bag and tied to the stake; 70 g Lifebuoy soap chips (no perfume) placed in cheese cloth bags and tied to the stakes; Lifebuoy perfume + Lifebuoy soap chips (no perfume) placed in cheese cloth bags and tied to the stakes; or untreated shoots—was placed on each of 24 stakes in the experimental design as described above (6 shoots/rep and 4 reps/treatment).

Experiment 10. On July 28, 1987, 24 apples of the following treatments—100 BGR; 100% Hot Sauce; ICI L-22; Lifebuoy (Scented); 50% Lifebuoy + 50% Hot Sauce; 100% Deer Blood; 100% dried cabbage + Vapor Gard; 100% cedar leaf oil; 100% Vapor Gard; or untreated control—

Table 2. Effect of various repellents on 24 treated apples presented to White-tailed deer on one meter stakes (1988).

Treatment (% ai)[z]	Formulation rate (%)	Apples fed on (%)														
		Day 1 experiment[y]					Day 2 experiments[y]			Day 3 experiment[y]				Day 4 experiment[y]	Day 6 experiment[y]	
		# 1	# 2	# 3	# 4	# 5	# 2	# 4	# 5	# 1	# 2	# 4	# 5	# 3	# 2	
Untreated control	—	54[y]	100	100	100	89	100	100	100	100	100	100	100	100	100	
Broccoli heads	—	0*								0*						
Thiram (65%)	20		100		96		100	100			100	100			100	
Hinder (15%)	100		63*				88				100				100	
Hot Sauce (2.5%)	100			4*	17*	7*		29*	53*			75*	96	96		
Hot Sauce (2.5%)	25				38*			100				100				
Hot Sauce (2.5%)	10				96			100				100				
Off Shoot T	100			100										100		
Lifebuoy perfume	100			39*	67*			100				100		100		
Bubble gum flavor	100				92			100				100				
Baby powder fragrance	100				58*			88				96				
Broccoli extract	100				96			100				100				
Diallyl sulfide	100					74*			94				100			
Piperine (20%)	25					100			100				100			

[z]Dates for each experiment were: Expt. # 1—April 2–3; Experiment # 2—July 28–August 3; Experiment # 3—July 30–August 3; Experiment # 4—August 4–7; Experiment # 5—August 28–31.

[y]Mean separation within columns by Duncan's Multiple Range Test, 5% level.

Table 3. Effects of various repellents placed *on or near* apple vegetative shoots that were presented to wild White-tailed deer on one meter stakes (1987)

Treatment[z]	Treatment method	Rate	Apple shoots damaged (%)															
			Day 1 experiment #				Day 2 experiment #				Day 3 experiment #				Day 6 experiment #			
			6	7	8	9	6	7	8	9	6	7	8	9	6	7	8	9
Control			33 y	42	50	31	38	71	54	56	38	79	83	61	—	92	92	83
Lifebuoy perfume	Painted on shoot stem	25 g perf/100 g paint	38				38				46				—			
½ bar Lifebuoy soap	Tied on stake near shoot	½ bar soap	0*	13*			0*	38*			8*	54			—	88		
Tree paint	Painted on 30 cm pc of tape & placed on stake near shoot	3.5 g/piece tape		67				71				71				100		
Tree paint + Lifebuoy perfume	Painted on 30 cm pc of tape & placed on stake near shoot	3.5 g (0.9 g perfume)		25				63				63				88		
Lifebuoy soap chips (no perfume)	In cheese cloth bag, tied on stake near shoot	150 g/bag		0*				25*				38*				92		
Baby powder + hot sauce	Sprayed on vegetative shoots	1%, 1% spray		25	13*			46	21*			63	38*			71	58*	
Hot Sauce	Sprayed on vegetative shoots	0.5% spray		13*	0*			33*	25*			46*	46*			71	75	
Lifebuoy perfume	Sprayed on vegetative shoots	1% spray		0*	4*			17*	50			33*	54*			75	58*	
Pine Sol	Sprayed on vegetative shoots	4% spray		38				42*				46*				88		
Off-Shoot T	Sprayed on vegetative shoots	1% spray			25				25*				54*				67*	
Thiram	Sprayed on vegetative shoots	5% spray			17*				42				54*				71	
Lifebuoy perfume	Soaked in cheese cloth bag	0.7 ml/bag				15*				59				53				76
Lifebuoy soap chips (no perfume)	Placed in cheese cloth bag	70 g/bag				19				39				39				63*
																		78
Lifebuoy perfume + Lifebuoy soap chips (no perfume)	Soaked in and placed into cheese cloth bag	0.7 ml + 70 g/bag				22				61				65				

[z]Dates for each experiment were: Expt # 1 (July 7–10); Expt #2 (July 21–27); Expt #3 (July 28–August 3); Expt #4 (August 11–17).

[y]Each treatment was compared in columns to the control by Chi-Square, 5% level (*) for each day after treatment.

were dipped for 5 seconds and one apple was placed on each stake in the experimental design as described above (6 apples/rep and 4 reps/treatment).

Experiment 11. On July 28, 1987, 24 apples of the following treatments—100% BGR; 100% Hot Sauce; ICI L-22; 100% Lifebuoy (Scented); 100% Lifebuoy (non-scented); 10% BGR; 10% Hot Sauce; 13% ICI; 10% Lifebuoy (scented); or untreated control—were dipped for 5 seconds and one apple was placed on each stake in the experimental design as described above (6 apples/rep and 4 reps/treatment).

Results and Discussion

Experiment 1. Broccoli heads were not fed on, but 54% of the apples were taken on the 1st day. No pre-test plant material had previously been attached to the stakes. All broccoli heads were replaced on the 2nd day with apples to attract deer to the stakes. Accidentally 3 broccoli heads were left on the stakes and these were not touched by deer during the next 5 days (Table 2). For this reason, apples were used as a desirable feeding indicator for future tests.

Experiment 2. A 20% Thiram solution did not inhibit deer browse to apples, however Hinder reduced feeding by 37%for the 1st day (Table 2). Hinder treated apples did not significantly differ from the untreated control on day 2 or day 6 (the next dates that data were taken).

Experiment 3. Hot Sauce (100%) reduced deer browse by 96% and Lifebuoy perfume by 61%, but not by Off Shoot T on the 1st day (Table 2). By day 4 (the next date data were taken), all treatments were not statistically different from the control.

Experiment 4. High concentrations of Hot Sauce (100% and 25%), but not 10% Hot Sauce, effectively reduced deer feeding to apples on the 1st day (Table 2). Hot Sauce (100%) remained significantly different from the control on day 2 and day 3, but the other treatments were not.

Experiment 5. Hot Sauce (100%) was statistically different from the control for day 1 and 2, but not on day 3 (Table 2). None of the other treatments were effective.

Experiment 6. Lifebuoy soap tied on the stake inhibited deer browse to the apple shoots for 1, 2, and 3 days (Table 3).

Experiment 7. Lifebuoy soap tied on the stake inhibited deer browse to the apple shoot for 2 days. Lifebuoy soap chips (no perfume) in a cheese cloth bag, and 1% Lifebuoy perfume sprayed on apple shoots inhibited deer browse for 3 days (Table 3).

Experiment 8. The 1% Hot Sauce + the 1% Lifebuoy and 1% Lifebuoy perfume sprayed on vegetative shoots inhibited deer browse for 6 days (Table 3) and 0.5% Hot sauce inhibited browse for 3 days.

Experiment 9. Lifebuoy perfume inhibited deer browse for 1 day and Lifebuoy chip (no perfume) inhibited deer browse for 3 and 6 days (Table 3).

Experiment 10. BGR, 100% Hot Sauce + 100% Lifebuoy soap applied to apples inhibited deer browse for 1 day. Low temperatures on the night of December 7, 1988 froze apples on the stakes and no data was collected on day 2 or 3 (Table 4).

Experiment 11. BGR, Hot Sauce, Lifebuoy soap (scented or unscented) effectively reduced deer browse on day 1, but only Lifebuoy soap reduced deer browse on day 2 (Table 4).

All of the experiments (#1–#11) were conducted in a highly protected area where reductions in the wild deer population by hunting were not permitted. The deer remained wild and appeared smaller than normal due to over population. This area provided a uniform and highly acceptable place to conduct repeated experiments with minimal human activity.

Table 4. Effect of various repellents on 24 treated apples presented to White-tailed deer on one meter stakes (1988).

		Apples fed on (%)					
		Day 1 experiment[y]		Day 2 experiment[y]		Day 3 experiment[y]	
Treatment[z]	Formulation rate (%)	# 10	# 11	# 10	# 11	# 10	# 11
Untreated control	—	92 ab[y]	100 a	Froze	100 a	Froze	100 a
Big Game Repellent	100	4 d	28 cd	out	100 a	out	100 a
Hot Sauce	100	4 d	4 d		100 a		100 a
ICI L-22	100	25 cd	75 abc		100 a		100 a
Lifebuoy soap chips (scented)	100	0 cd	0 d		50 b		75 a
Lifebuoy soap chips (unscented)	100		4 d		21 b		75 a
Big Game Repellent	10		100 a		100 a		100 a
Hot Sauce	10		88 a		100 a		100 a
ICI	13		83 ab		100 a		100 a
Lifebuoy soap chips (scented)	10		33 abc		100 a		100 a
Lifebuoy soap chips (scented)	100	4 d					
+ Hot Sauce	100						
Deer blood	100	50 bc					
Dried cabbage							
+ Vapor gard	100	79 ab					
Cedar leaf oil	100	83 ab					
Vapor gard	100	100 a					

[z]Dates for each experiment were: Expt. # 10—December 6–9 (Low temperatures on the night of 7 Dec 88 froze apples on the stakes and no further data was collected); Experiment #11—December 20–23 (Rain occurred 21–22 Dec 88 and may have washed some of the repellent off the apples).

[y]Mean separation within columns by Duncan's Multiple Range Test, 5% level.

The data indicated that repellents are not very effective for reducing deer browse to highly desirable food materials under very high deer pressure. However, a test system of this nature can quickly determine statistically the relative effectiveness of repellents.

Since the unscented soap was as effective as the perfumed soap in these tests, we have concluded that the soap perfume was not necessary for activity; however, the perfume had some repellency when sprayed on apple shoots or when apples were dipped in 100% perfume. Dilution of all of the repellents reduced their effectiveness.

Literature Cited

1. Anthony, R.C. and A.R. Fisher. 1971. Wildlife damage in orchard—a need for better management. Wildlife Soc. Bul., Vol. 5(3):107–122.

2. Berry, R.N. 1948. Orchards versus deer. American Fruit Grower, Vol. 68(11):13, 18, 26.

3. Byers, R.E. and P.F. Scanlon. 1987. Control of deer browse damage to young apple trees with bar soap. Amer. Fruit Grower 107:8.

4. Campbell, D.L. and J. Evans. 1977. Guidelines for field evaluations of repellents to control deer damage to reforestation. Test Methods for Vertebrate Pest Control and Management Materials, ASTM STP 625, W.B. Jackson and R.E. Marsh (Eds.), Amer. Soc. Testing and Materials. pp. 145–150.

5. Gauditz, Illo. 1977. Bioassay methods guiding the development of a big game repellent. Test Methods for Vertebrate Pest Control and Management Materials, ASTM STP 625, W.B. Jackson and R.E. Marsh, (Eds.), Amer. Soc. Testing and Materials. pp. 34–46.

6. Katsma, D.E. and D.H. Rusch. 1979. Evaluation of deer damage in mature apple orchards. Vertebrate Pest Control and Management Materials, ASTM STP 680, J.R. Beck, (Ed.), Amer. Soc. Testing and Materials. pp. 123–142.

7. Matschke, G.H., D.S. de Calesta, and J.D. Harder. 1984. Crop Damage and Control. ch pt 38:647–654. *In: White-tailed Deer Ecology and Management*. Slackpole Books, Harrisburg, PA. 870p.

8. SAS Institute Inc. 1985 SASS Users Guide: Statistics Version 5. SAS Institute Cary, N.C.

9. Steel, R.G.D. and J.H. Torrie. 1960. Principles and Procedures of Statistics. McGraw Hill, New York 481p.

Plant Response to Container Planting Method and Media[1]

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Abstract

Shoot dry weight and relative root density of *Ilex crenata* Thunb. 'Compacta' and *Rhododendron obtusum* (Lindl.) Planch. 'Hino Crimson' were greater when liners were transplanted into holes with a core removed (excavated) compared to holes formed by compression (dibbled). Growth index, relative root density, and shoot dry weight increased as the percent pine bark in the growth media increased from 50% to 80 or 90% pine bark with holly and from 50% to 90% pine bark with azalea. Bulk density decreased and air porosity and irrigation frequency increased as the percent pine bark in pine bark:sandy loam container media increased from 50% to 100%. In a second experiment, root density and shoot dry weight of *Ilex crenata* Thunb. 'Helleri', but not *Rhododendron* × 'Trouper', were greater in pine bark and pine bark-sandy loam media when the planting hole was excavated rather than dibbled. Plant growth of the 2 species in peat-based media was not influenced by planting method.

Index words: nursery crops, container production, container culture

Species used in this study: 'Compacta' and 'Helleri' hollies (*Ilex crenata* Thunb. 'Compacta' and 'Helleri'); 'Hino Crimson' azalea (*Rhododendron obtusum* (Lindl.) Planch. 'Hino Crimson'); 'Trouper' azalea (*Rhododendron* × 'Trouper').

Significance to the Nursery Industry

Placement of controlled-release fertilizer directly under the liner at transplanting is an effective method of fertilization that avoids media storage and mixing problems. However, plant growth may be adversely affected if the planting hole is formed by compression (dibbling) rather than removal of a core (excavating). This effect is more likely to occur in pine bark-based media that do not contain peat than in peat-based media.

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Introduction

Controlled-release granular fertilizers are typically applied either uniformly incorporated into growth media or surface-applied as a topdressing (6, 7). Incorporation has proven successful in a wide range of applications, but uniform blending is essential and subsequent storage for more than a week is not recommended due to the potential release of fertilizer salts. Longer storage necessitates leaching prior to planting to avoid phytotoxicity, but wastes fertilizer and could result in undesirable pollution of the surrounding area. Intermittent drying of surface-applied fertilizer slows release due to a lack of continuous moisture (1, 8), and fertilizer may be lost if the container is overturned or rapidly flooded.

Placement of the fertilizer directly under the liner at transplanting (dibbling) is a third method that presents no storage,