ADVANCING DEER REPELLENT PERFORMANCE: FINE-TUNING HINDER APPLICATIONS AND POTENTIAL USES FOR INSECTICIDAL SOAPS

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Deer feed on buds, shoots, leaves and fruit (Scott and Townsend 1985), and cause substantial economic losses for many apple producers (Purdy et al. 1987). A variety of mitigation techniques are used to control such damage including deer population reduction via hunting, exclusion fencing and scare devices. However, most commercial apple producers rely on home-made or commercial repellents to control deer damage (Purdy et al. 1987). Despite their popularity, repellents have often provided only limited or highly-variable control (Conover 1984, 1987, Hygnstrom and Craven 1988). There is considerable need to improve the performance of existing repellents, or to identify new materials which are effective at preventing damage.

Hinder is a commercial deer repellent which is widely used in fruit orchards due to its effectiveness (Palmer 1983, Conover 1984, 1987), comparative low cost, and broad legally-registered uses. The active ingredient in Hinder is 15% ammonium soaps of higher fatty acids (R. Choban, pers. commun.). Producers report Hinder's effectiveness diminishes rapidly when exposed to precipitation, and consider the need for frequent reapplications a major drawback of the product. Some producers have attempted to prolong Hinder's effectiveness by mixing it with other stickers. The outcome of these efforts are either anecdotal or unknown. We were unaware of any controlled studies which evaluated if adding sticker to Hinder enhanced or prolonged its repellent properties. Safer Insecticidal Concentrate (hereafter called Safer) is a commercial insecticide also sold under the trade name M-Pede. Safer's active ingredient consists of 49% potassium salts of fatty acids (P. Bystrak, personal communication), and has been marketed as a more environmentally-safe alternative to many other insecticides. We received anecdotal reports from farmers suggesting that Safer possessed repellent properties, but were unaware of studies which evaluated its effectiveness in reducing deer damage.

In this study, we compared the effectiveness of Safer and Hinder in preventing deer damage to dormant apple trees during each of two winter seasons. In the second year of the project, we also evaluated whether adding a sticker to Hinder improved its effectiveness as a repellent. Test materials were provided by Leffingwell Chemical Group of Uniroyal Chemical Company Incorporated (Hinder), Mycogen Company (Safer and M-Pede) and the Miller Chemical and Fertilizer Corporation (Vapor Guard sticker). We thank producers G. VanDuser, R. Dressel and C. Innis for allowing us to use their orchards. This work is a contribution to the Cornell Wildlife Damage Management Program, and was supported by funds from USDA APHIS/ADC and the NY Cooperative Fish & Wildlife Research Unit.

METHODS

1991 Repellent Bioassay:

This experiment was conducted in Ulster County, New York in a 6 year-old "Jonamac"/mm106 apple orchard with a history of extensive deer damage. We divided the orchard into 4 30-tree blocks, and within each block we randomly assigned 10 trees to one of the treatments or to serve as unsprayed controls. The treatments consisted of Hinder at the labeled rate of 5 gallons per 100 gallons of water, and Safer applied at 2 gallons of concentrate per 100 gallons of water. This represents the maximum rate of Safer allowed by label for insect control. We clipped previously-

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browsed stems on all trees prior to treatment applications to facilitate future damage identification. Repellent applications were made using a backpack sprayer on 21 February, 1991. Trees were sprayed to runoff.

A single comprehensive damage assessment was conducted 21 days after application of the repellents. This assessment consisted of counts of the number of browsed stems per tree. We pooled treatment counts by block, and transformed these data using the square-root transformation (square-root (Y + 0.5), Steel and Torrie 1980) to stabilize the error variances. We used the mean number of browsed stems to represent the intensity of deer damage on treatment and control plots. As a measure of the extent of damage, we calculated the proportion of browsed trees per block for individual treatments and controls. We converted these proportions using the arc-sine transformation after substituting 25/n for 0% and 100-25/n for 100% (Steel and Torrie 1980). Statistical analyses included analysis of variance and Duncan's multiple range test, which were conducted using the GLM procedure of the SAS Statistical Package (SAS Institute 1985).

1992 Repellent Bioassays:

Repellent bioassays were conducted in 2 commercial apple orchards in Ulster County, New York during 1992. The Dressel Farms site consisted of 6 rows of 7-year-old "Red Delicious"/mm111 apple trees, and was surrounded by other orchards. The Innis Orchards site included 4 rows of 6-year-old "Jonamac"/mm111 trees adjacent to 2 rows of "Empire"/mm111 trees. The Innis site bordered orchards, woodlots and open fields. Both sites had histories of extensive deer damage.

In this test we evaluated Hinder and Safer at the 1991 repellent bioassay rates. In addition, we tested Hinder at the same rate with the addition of 2 quarts of Vapor Guard sticker per 100 gallons of water.

Four plots consisting of 10 adjacent trees were identified in each row at both sites. We separated plots by 5 and 3 buffer trees at the Dressel Farms and Innis Orchard sites, respectively to avoid inter-plot repellent interactions. Plots located in the 2 outer rows at each site were not sprayed, but served as outer controls to measure deer pressure on the entire orchard (Ellingwood and McAninch 1984). Plots in each of the 4 middle rows at both sites were randomly assigned to of the treatments or as unsprayed controls. We clipped all previously-damaged stems prior to repellent applications to facilitate future damage identification. Treatment applications were made using a backpack sprayer on 7 January, 1992, with all trees sprayed to runoff.

Three bi-weekly damage assessments were conducted at each site. A fourth and final assessment was conducted 49 days after initial repellent applications. During each assessment we counted and clipped damaged stems on each tree. Counts of damaged stems for each 10-tree plot were pooled over the 49-day period. We compared damage levels of outer control plots between sites using the SAS T-test procedure (SAS Institute 1985). Data transformations and statistical analyses of treatment and inner control plots were conduced as in the 1991 repellent bioassay.

RESULTS

1991 Repellent Bioassay:

The extent and intensity of deer damage was limited during this study. The proportion of trees damaged per block averaged 13%, 15% and 35% for Hinder, Safer and control trees, respectively. Deer damage averaged 2.3 stems per block for both Hinder and Safer treatments compared to 12.8 stems for control trees. The proportion of damaged trees per block (Table 1) and the number of browsed stems per block (Table 2) averaged significantly less for each treatment plot compared to control plots. No differences in damage levels were found between treatments.

1992 Repellent Bioassays:

The proportion of trees damaged by deer in outer control plots averaged 75% on the Innis Orchard site compared to 90% at the Dressel Farms site. These damage levels were not significantly different from each other (Table 3). The intensity of deer damage, as measured by the average number of damaged stems per plot, was 45 per plot on the Innis Orchards site and was significantly less than the mean value of 134 browsed stems per outer control plot recorded at the Dressel Farms site (Table 3). Overall, deer pressure was moderate on the Innis Orchard site, and intense on the Dressel Farms site during this bioassay.

Table 1. Effects of treatment on the mean proportion of damaged apple trees per block[a] (N = 4 blocks) in the 1991 repellent bioassay.

Sources of Variation	F	P>F	Proportion of browsed trees[b]		
			Control	Safer	Hinder
Model	5.06	0.036			
Block	3.42	0.09			
Treatment	7.53	0.023	0.62	0.39	0.35

[a] Data were transformed using the arc-sine transformation.

[b] Treatment means connected by lines were not different (Duncan's multiple range test, P = 0.05).

Table 2. Effects of treatment on the mean number of browsed stems per block[a] (N = 4) in the 1991 repellent bioassay.

Sources of Variation	F	P > F	Number of of browsed stems[b]		
			Control	Safer	Hinder
Model	7.61	0.014			
Block	3.04	0.114			
Treatment	14.47	0.005	3.53	1.59	1.57

[a] Data were transformed using the arc-sine transformation.

[b] Treatment means connected by lines were not different (Duncan's multiple range test, P = 0.05).

Table 3. Deer damage to outer control plots (N = 8) on moderate versus intense deer-pressure sites in the 1992 repellent bioassays.

Deer pressure	Mean % trees damaged[a]	t	P > t	Mean number stems browsed[b]	t	P > t
Moderate	1.08	1.52	0.15	6.40	4.84	0.0003
(Innis Orchards)						
Intense	1.26			11.45		
(Dressel Farms)						

[a] Arc-sine transformed means.

[b] Square-root transformed means.

Table 4. Effects of treatment on the mean proportion of damaged trees per block[a] (N = 4 blocks) for moderate and intense deer pressure sites during the 1992 repellent bioassays.

Deer Pressure	Sources of Variation	F	P > F	Proportion of browsed trees[b]			
				Control	Hinder	Safer	Hinder + Vapor Guard
Moderate	Model	20.41	0.0001				
(Innis Orchards)	Block	1.91	0.2				
	Treatments	38.91	0.0001	0.91	0.3	0.24	0.20
Intense	Model	12.62	0.0006				
(Dressel Farms)	Block	7.03	0.0099				
	Treatments	18.22	0.0004	0.95	0.67	0.57	0.41

[a] Data were transformed using the arc-sine transformation.

[b] Treatment means connected by lines were not significantly different (Duncan's multiple range test, P = 0.05).

The extent of deer damage, as measured by the mean proportion of trees damaged per 10-tree plot, was significantly less on treated trees compared to controls at both sites (Table 4). At Innis Orchards, the proportion of trees damaged by deer averaged 3%, 5%, 13% and 63% on the Hinder plus Vapor Guard, Safer, Hinder, and control trees, respectively (Fig. 1). The proportions of trees damaged by deer were 17%, 30%, 38% and 65%, respectively at the Dressel Farms site (Fig. 2). We found no differences in the proportions of damaged trees between treatments at the Innis Orchard site (Table 4). However, a significantly smaller proportion of trees treated with Hinder plus Vapor Guard were damaged by deer compared to trees treated with Hinder alone at the Dressel Farms site. At both sites, mean damage levels to Safer-treated trees did not differ from levels for either of the Hinder treatments.

The intensity of damage was also significantly less on treated trees compared with controls at both sites (Table 5). The number of browsed stems per plot averaged <1, 1, 3 and 30 stems for Hinder plus Vapor Guard, Safer, Hinder, and control plots, respectively at the Innis Orchards site (Fig. 3). Damage levels averaged 7, 19, 13, and 93 browsed stems for the same plots, respectively at the Dressel Farms site (Fig. 4). No differences in the average number of browsed stems were found between treatments at Innis Orchards. In contrast, plots treated with Hinder plus Vapor Guard averaged significantly fewer browsed stems than plots treated with only Hinder at Dressel Farms (Table 5). At both sites, Safer-treated plots had damage levels which were not different from levels observed for either Hinder treatments.

DISCUSSION

The success of repellents in reducing deer browsing appeared to be related to both the inherent effectiveness of the product and the intensity of deer foraging pressure at the site. Ellingwood and McAninch (1984) reported differences in the effectiveness of several repellents applied at sites with moderate deer pressure, but found no differences between products in areas with light or intense damage levels. In our study, the greatest separation of repellents was acheived at the site with the most intense deer pressure.

The addition of Vapor Guard sticker to Hinder increased its cost 28%. Based on our results, adding a sticker like Vapor Guard to Hinder appears warranted on sites where winter deer pressure is expected to be intense. However, the addition of a sticker to Hinder may increase spray costs unnecessarily when winter deer damage is expected to be light to moderate, as no differences in effectiveness under moderate pressure were observed during this study. Further evaluations of Hinder with different stickers or sticker concentrations may provide justification for increasing spray costs under other potential deer pressure situations. Continued research in this area appears warranted.

The additional costs associated with adding a sticker to Hinder on sites with potential for light to moderate damage may be worthwhile during the growing season. However, in a yet unpublished study we found a single mid-season (July) Hinder spray applied to bearing trees resulted in significant spray burn damage to fruit of 2 commercial apple varieties. Trees treated with Hinder early in the growing season (at first cover) showed no significant fruit damage. Hinder remains a repellent of choice for commercial apple producers protecting non-bearing trees during all seasons, and bearing trees in the dormant season. However, if fruit finish is an important concern, we recommend against its use on bearing trees during the growing season until more information is available on the conditions which lead to fruit damage.

Safer performed as an effective deer repellent, although it's current Environmental Protection Agency label does not allow it to be applied for this purpose. During the growing season, producers suffering deer damage could legally apply Safer as an insect control treatment and might benefit by reducing their deer damage losses without incurring the costs associated with applying additional repellents. To be successful, this application strategy necessitates Safer would provide cost-effective control of the target insect pests.

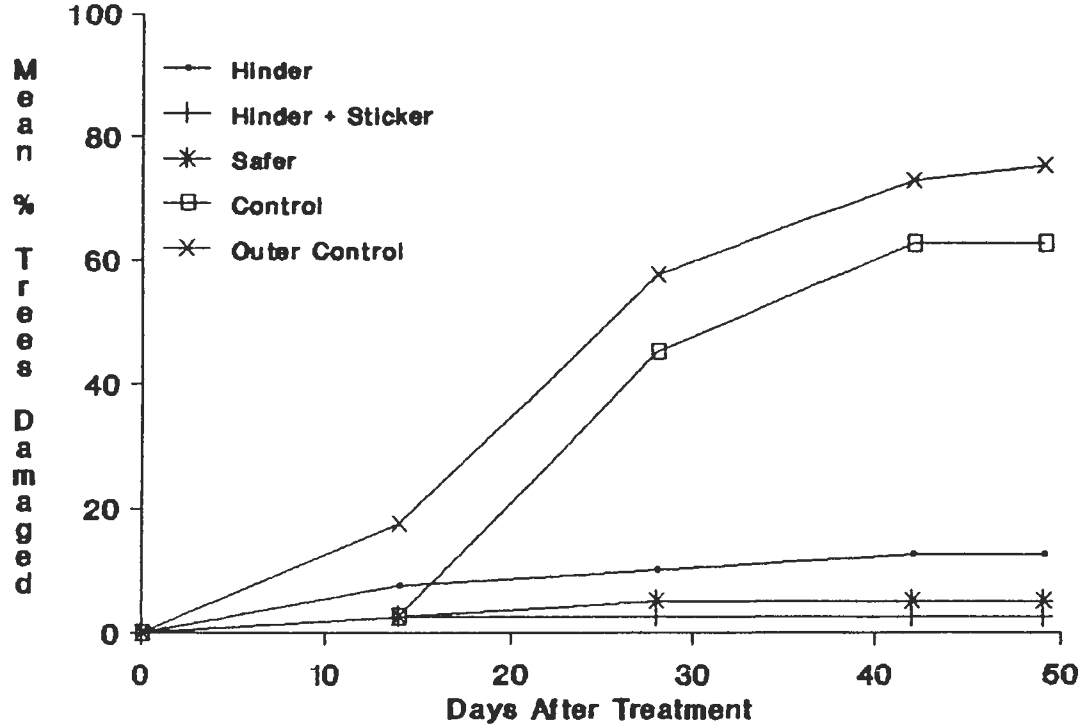

Fig. 1. The cumulative mean proportion of browsed trees per plot (N = 4) for Hinder, Safer and untreated control plots under moderate deer pressure during the 1992 repellent bioassay.

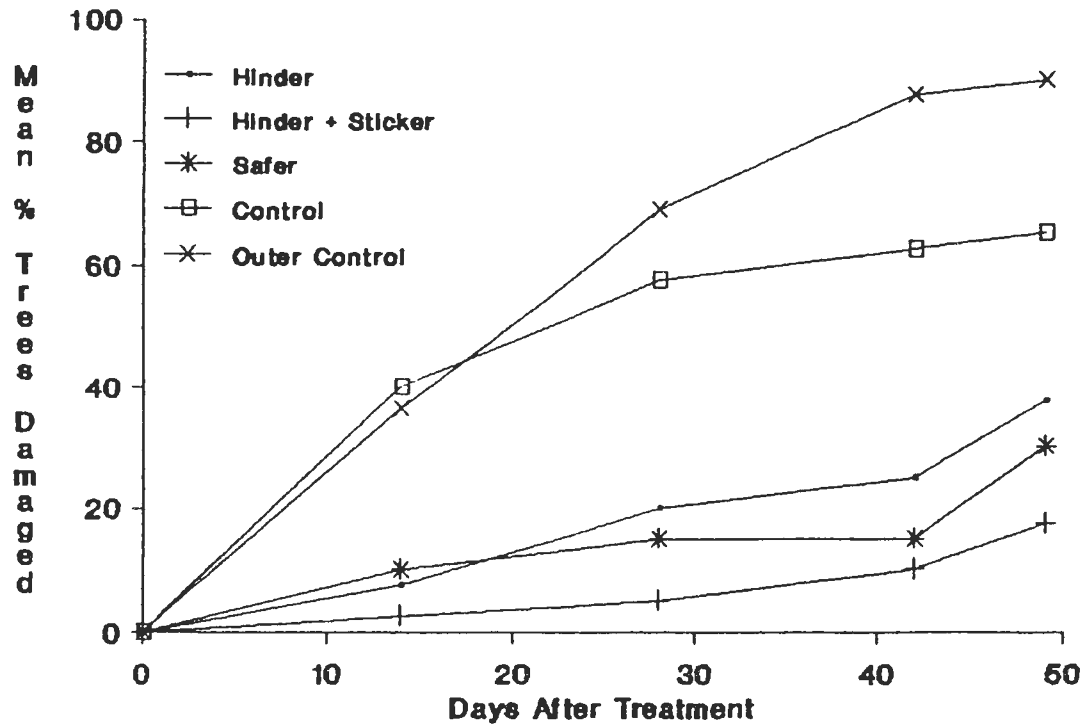

Fig. 2. The cumulative mean proportion of browsed trees per plot (N = 4) for Hinder, Safer and untreated control plots under intense deer pressure during the 1992 repellent bioassays.

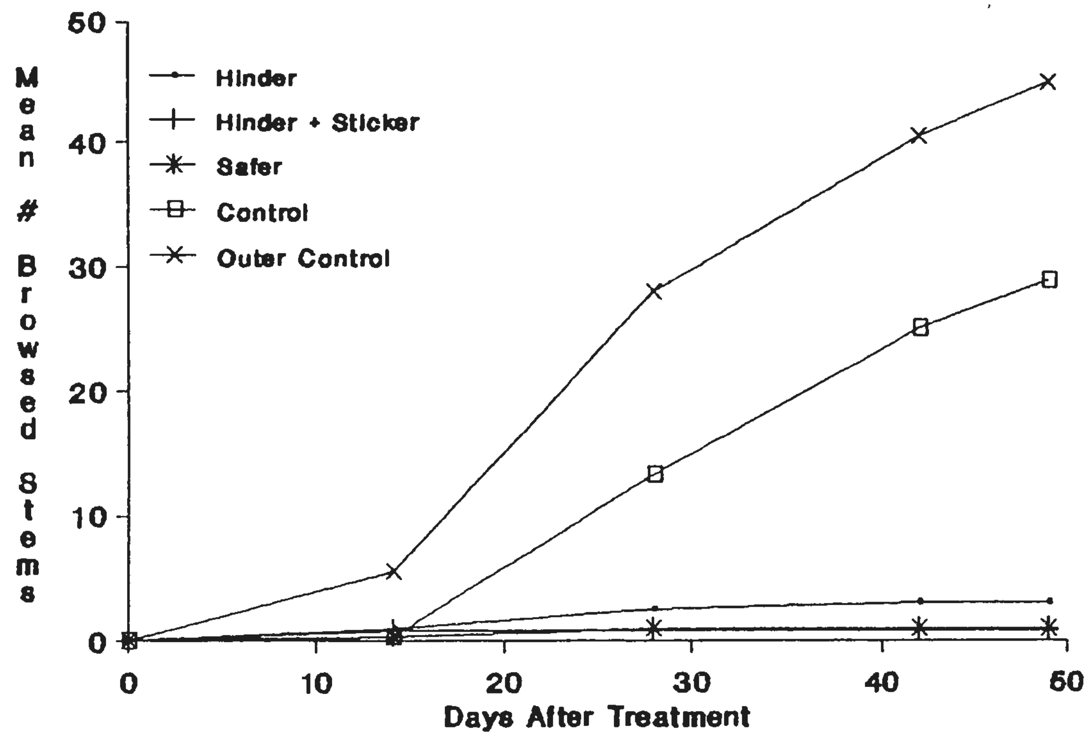

Fig. 3. The cumulative mean number of browsed stems per plot (N = 4) for Hinder, Safer and untreated control plots under moderate deer pressure in the 1992 repellent bioassays.

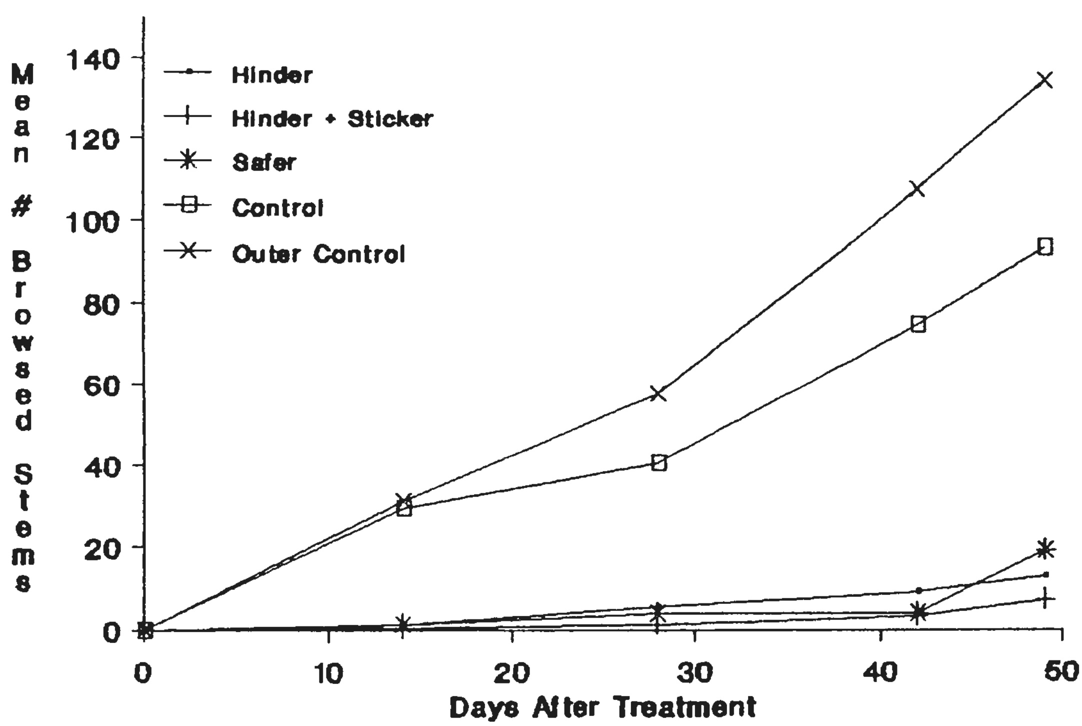

Fig. 4. The cumulative mean number of browsed stems per plot (N = 4) for Hinder, Safer and untreated control plots under intense deer pressure in the 1992 repellent bioassays.

Table 5. Effects of treatment on the mean number of browsed stems per block[a] (N = 4 blocks) for moderate and intense deer pressure sites during the 1992 repellent bioassays.

				Number of browsed stems[b]			
Deer Pressure	Sources of Variation	F	P > F	Control	Hinder	Safer	Hinder + Vapor Guard
Moderate	Model	10.53	0.0012				
(Innis Orchards)	Block	0.91	0.47				
	Treatments	20.14	0.0002	5.3	1.7	1.1	1.0
Intense	Model	48.98	0.0001				
(Dressel Farms)	Block	19.13	0.0003				
	Treatments	78.83	0.0001	9.5	4.0	3.5	2.6

[a] Data were transformed using the arc-sine transformation.

[b] Treatment means connected by lines were not significantly different (Duncan's multiple range test, P = 0.05).

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