Effectiveness of Varpel Rope® on Norway Rats and House Mice in Laboratory and Field Conditions

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ABSTRACT

This study is based on observations made during the efficacy testing for EPA product approval of Varpel Rope®, a temporary repellent for Norway rats *(Rattus norvegicus)* and the house mouse *(Mus musculus)*. Animals were tested under both laboratory and field conditions. Laboratory testing was conducted at Arkansas State University, Jonesboro, AR, and resulted in 75-97% repellency. Field testing that resulted in repellency rates from 50 to 100%, was conducted in Newport, AR. Over 140 hr of videotape were recorded during the 1,800 individual laboratory and field trials. Testing was conducted from June 1989 through May 1992.

KEY WORDS

house mouse, Mus musculus, Norway rat, Rattus norvegicus, repellent, Varpel Rope®

INTRODUCTION

This project was designed to conduct efficacy testing of the purported commensal rodent repellent Varpel Rope® for EPA registration data requirements. The rope consists of paper, similar to that used in tea bags, with separate compartments containing the active ingredient. The active ingredient, para-dichlorobenzene (PDCB), is an insecticidal fumigant of restricted usefulness and low potency. It is widely recognized as a repellent for the clothes moth (Mallis 1990). In an enclosed space PDCB will slowly volatilize until the vapors fill the space. Higher temperatures will increase the release of vapors and create higher concentrations. Minor eye and nasal irritation have been reported with exposure to PDCB vapors at concentrations as low as 50 ppm. Because of this, PDCB may have some effectiveness in rodent control (Timm 1983); but any data to this effect has gone either unreported or unpublished in the current literature. This study evaluates the effectiveness of Varpel Rope as a rodent repellent under both laboratory and field conditions.

MATERIALS AND METHODS

Phase I—Laboratory Testing

Testing was conducted in an open-topped plexiglas enclosure 2.4 $m^2 \times 0.9$ m high, with three sides covered with black plastic to prevent outside disturbance. The fourth side was left uncovered to permit videotaping (Dewsbury 1983). The floor of the enclosure was covered with sawdust to provide traction and a natural substrate for the animals. Varpel Rope was placed in the center of the enclosure forming a 0.9×0.9 m^2 barrier. Initially, food and water were placed only inside the Varpel Rope barrier; during subsequent trials, an alternate food/water source was also placed outside the Varpel Rope barrier. Test animals used during this part of the study were captured at the Bottomland Naturals facility, Newport, AR, using unbaited Sherman rodent live traps. Animals captured were identified as House mice and Norway rats (Jackson 1982). Videotaping was recorded with a Zenith Color VHS Video Camera (Model No. VC1100) located approximately 3.4 m from the enclosure. Videotaping was conducted over 6 hr with no humans present, thus eliminating potential distractions.

Phase II—Laboratory Testing

Testing was conducted in a modified "T" maze ("Y"-shaped), with an overall length of 2.66 m and wings that were 61 cm^2. In this phase, we used white laboratory mice (CF1) and white laboratory rats (Sprague Dawley) (Altman and Katz 1979). We purchased 20 mice and 20 rats from SASCO, Inc., and placed them in quarantine for approximately 4 weeks, as required by Arkansas State University animal facility protocol. Rats and mice were housed in individual cages, with water ad libitum, 12-hr photoperiods, and no handling except for weighing. The study animals were placed on a diet limiting daily food intake to 20% of total body weight for the duration of the trial. Body weights were recorded weekly using a triple beam balance and used to adjust diet as necessary. Animals were divided by species into two groups (10 control and 10 test). Testing was conducted on a weekly basis and test animals were fed sunflower seeds with normal food (Purina rat and mouse chow) 1 day prior to testing. Animals were transported to the testing area via covered individual cages to protect animals and minimize any disturbance due to weather or transport.

Sunflower heads were placed in each of the upper right or left wings of the maze, and test animals were individually placed at the bottom of the "Y" maze. Varpel Rope and placebo rope material were randomly placed across the ends of the respective branches between the animals and the sunflower heads. The placing of Varpel Rope or placebo material in either the left or right wings was determined by a table of random numbers. Early testing demonstrated that scent trails would also have to be considered in determining placement of Varpel Rope or placebo material. The first two or three animals explored the maze and finally encountered the test article. The remaining test animals, when placed in the maze, did not explore the maze but simply followed scent trails of the previous animals. Later tests were altered to allow the first two or three animals to explore and encounter the test article and lay down scent trails. The test article was then shifted to block this trail. Animals were allowed to move freely for up to 5 minutes within the maze with

no outside disturbance. Encounters with Varpel Rope and placebo rope were recorded manually.

Phase I—Field Testing

Field testing was conducted at the Bottomland Naturals facility in an area that had previously demonstrated high rodent activity. Several sunflower heads were placed on the floor in the center of the room with a video camera located approximately 2–3 m away. Filming was conducted at night over 2 consecutive weekends to minimize human influence on rodent activity. The initial stage of filming was done without Varpel Rope present in order to assess normal levels of rodent activity and to establish the food preference of the test animals. The final stage of filming involved the same criteria already established, but with Varpel Rope surronding the sunflåwer heads for 36 consecutive hr.

Phase II—Field Testing

This phase of field testing involved three different locations: (1) Farmer's Elevator and Warehouse, (2) Holden Connor Seed Company, and (3) Rutledge Farms, Incorporated—all in the Newport, AK, area. All sites had established rodent infestations, as evidenced by the presence of live rodents and fecal droppings. Prebaiting was done for 2 weeks prior to testing in order to determine the level of actual rodent activity and to establish bait stations. Testing involved the placement of two wooden pallets (A and B) at each site, 1.5 m from surrounding cover on three sides and 2.5 m from one another. A cardboard coverslip was placed on each pallet, with a dish containing sunflower seeds placed in the center of the pallet. The first pallet (A) was then surrounded by the Varpel Rope. The other pallet (B) was surrounded by the placebo rope material. Prior to testing, sunflower seeds were counted into groups of 100 seeds and labeled according to test date, location, and pallet. When placed, seeds were allowed to remain on individual pallets for 24 hr. Seeds were then picked up, and a new group of 100 seeds was placed in the dish on a daily basis for 6 days. The number of seeds remaining each day was tabulated and recorded.

Test animals for both phases of the field testing consisted of the natural occurring commensal rodent populations of the house mouse and Norway rat. This had been confirmed by live-trapping of specimens prior to the start of each study.

RESULTS

Phase I of both laboratory and field tests involved filming over a specific period of time, reviewing tapes later, and counting repulsions or crossings of Varpel Rope. The repellent effects was determined according to the following formula:

$$\% \text{ Repellency} = 100 - \left[\frac{\text{\# of crosses}}{} \times 100 \right]$$

Table 1 shows the results from 1,000 trials in the laboratory. Table 2 shows the results of field trials with and without alternate food sources. These combined yielded approximately 1,800 trials and demonstrated a 60–80% repellency.

Table 1. Percent Repellency of Varpel Rope® during Phase I of Laboratory Trials

Date	Successful Repulsion	Barrier Compromise	Total Encounters	Percent Repellency
July 1989	228	54	282	81
August 1989	334	90	424	79
September 1989	185	109	294	63
Total	747	253	1,000	75

Table 2. Percent Repellency of Varpel Rope® during Phase I of Field Trials

Time (hr)	Successful Repulsion	Barrier Compromise	Total Encounters	% Repellency
1–6[a]	84	22	106	79
6–12[a]	105	411	516	26
12–18[a]	0	1	1	0
18–24[b]	43	25	68	100[c]/63[d]
24–30[b]	5	5	10	50
30–36[b]	82	52	134	90[c]/61[d]
Total	319	516	835	80[c]/62[d]

[a] No outside food
[b] Outside food source
[c] Percent with outside food
[d] Percent after outside food consumed

Phase II of laboratory testing resulted in repellency of 97% (Table 3*a*), using the above formula. Table 3*b* shows the repellency of the placebo material.

In Phase II of field testing, 18 trials were conducted (two per site/three sites) for 6 days. The data for each test are individually reported (Table 4). The repellency for each site was determined according to the following formula (Greaves 1976):

$$\% \text{ Repellency} = \left[\frac{\text{\# of seeds remaining in plot}}{\text{\# of seeds possible in plot}} \times 100 \right]$$

Inserting the daily data into the above formula gives the repellency indices for Varpel Rope®.

DISCUSSION

It became evident in the early trials (Phase I) that the animals displayed habituation and learning behaviors when exposed to Varpel Rope for periods of greater than 6–8 hr without other pest control measures (Table 2). There was also the question of whether the PDCB or neophobic behavior produced the repellency. During Phase I of laboratory testing, an alternate food/water source was provided so the animals would have a choice whether to cross the Varpel Rope barrier and not be driven across by hunger or thirst. This same problem also became evident in the first phase of field testing. The purpose of Varpel Rope is a temporary deterrent to rodents by diverting them to an alternate food/water source (poison bait, traps, etc.) and to keep them away from items within the enclosed area. It is because of these circumstances that Phase II of laboratory and field testing was undertaken. Animals in Phase II testing were also provided a choice between Varpel Rope and the placebo rope material (Tables 3*a,b*). As previously stated, field testing during this Phase II was done at three different locations with historical rodent problems. Field tests were designed to not only provide a visual record of Varpel Rope's ability to prevent rodent damage, but also data that could be equated to estimated costs in rodent damage (Table 4). The repellent effect of Varpel Rope during Phase I of laboratory and field testing varied from 50–80% (Tables 1 and 2). Even low repellency levels still equates to a cost savings in reduced product damage. Testing during Phase II resulted in 98% repellency and evidence that this effect was due to the presence of the active ingredient (PDCB), and not neophobia.

Varpel Rope is designed as a temporary repellent for the Norway rat and house mouse and will be used in conjunction with other integrated pest control measures. The design of Varpel Rope allows it to be placed around the object to be protected and easily removed. It will act as a deterrent to rodents by causing them to choose other paths or food sources, allowing traps or other methods to eliminate the rodents. In many cases, this will reduce the number of animals that have encountered the rope and thereby eliminate potential learning.

Table 3a. Percent Repellency of Varpel Rope® during Phase II Laboratory Testing

Species	Sex (No.)	Total Encounters	Total Crosses	% Repellency
House mouse	M(5)	43	0	100
House mouse	F(5)	47	4	91
Norway rat	M(5)	39	0	100
Norway rat	F(5)	44	0	100

Table 3b. Percent Repellency of Placebo Rope during Phase II Laboratory Testing

Species	Sex (No.)	Total Encounters	Total Crosses	% Repellency
House mouse	M(5)	25	25	0
House mouse	F(5)	22	21	5
Norway rat	M(5)	27	25	7
Norway rat	F(5)	24	19	21

Table 4. Phase II of Field Test Showing Numbers of Seeds Present Each Day of Testing (Columns with (A) Represent Plots with Varpel Rope®; Columns with (B) Represent Plots with Placebo Rope)

Location	FE[1]		HCSC[2]		RF[3]	
Pallet	1A	1B	2A	2B	3A	3B
Day 1	100	100	100	100	100	97
Day 2	100	98	100	99	100	94
Day 3	100	98	100	95	100	97
Day 4	100	93	100	94	100	55
Day 5	100	93	100	94	99	74
Day 6	100	99	99	91	98	84

[a] FE = Farmers Elevator and Warehouse
[b] HCSC = Holden Connor Seed Company
[c] RF = Rutledge Farms, Incorporated

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